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ARTICLE

Building the Ohio Hopewell Chronology: An Incremental Approach to Historical Reckoning

Mark F. Seeman[1] and Kevin C. Nolan[2]

[1]Department of Anthropology, Kent State University, Kent, OH, USA, and [2]Applied Anthropology Laboratories, College of Sciences and Humanities, Ball State University, Muncie, IN, USA
Corresponding author: Mark F. Seeman, Email: mseeman@kent.edu

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Abstract
Ohio Hopewell is an archaeological concept that is known worldwide but that suffers from "a disarray of radiocarbon results" (Lynott 2015:60). Here, we establish a comprehensive dataset of 425 ^{14}C dates from Ohio Hopewell sites and apply formal chronometric hygiene criteria to all dates. We then iteratively assess the temporal placement and span of the six most important Ohio Hopewell sites—the Hopewell Mound Group, Liberty, Mound City, Seip, Tremper, and Turner. A staged relaxation of hygiene criteria for our best three categories (Classes 1–3) permits alternate but generally consistent conclusions. As the first large-scale analyses of Ohio Hopewell temporality since the publication of IntCal20 (Reimer et al. 2020), the available data show a ritual complex that begins 90 or more years later than generally has been recognized circa 2010 ^{14}C BP, or as Bayesian modeled, *AD 90–120*. Our analysis reveals site histories of differing spans, more late dates than early dates, and with most Hopewell activity ending across these sites circa 1640 ^{14}C BP, or as Bayesian modeled, *AD 395–430*. An increased consideration of contingency in contemporary temporal reckoning increases the utility of the historical narratives that we as archaeologists can construct.

Resumen
"Ohio Hopewell" es un concepto arqueológico conocido a nivel mundial, sin embargo, "sufre de falta de orden en sus fechamientos de radiocarbono" (Lynott 2015:60). En este trabajo se presenta una significativa colección de 425 fechamientos de ^{14}C provenientes de sitios Ohio Hopewell y aplicamos criterios de higiene cronométrica para cada uno de ellos. Con base en los resultados de mayor higiene cronométrica evaluamos la temporalidad y la ocupaciónz de los seis sitios más importantes de Ohio Hopewell—Hopewell, Liberty, Mound City, Seip, Tremper, y Turner. Exploramos los efectos sobre la temporalidad de las actividades Hopewell a través de una relajación escalonada de los criterios de higiene y encontramos que las fechas en nuestras tres mejores categorías (Clases 1–3) son consistentes en los rangos temporales implícitos. Como los primeros análisis a gran escala de la temporalidad de Ohio Hopewell desde la publicación de IntCal20 (Reimer et al. 2020), los datos disponibles muestran un complejo ritual que comienza 90 o más años más tarde de lo que generalmente se ha reconocido alrededor de 2010 ^{14} C aP, o como modelo Bayesiano, *90–120 dC*. Nuestro análisis revela historias de sitios de diferentes lapsos, más fechas tardías que fechas tempranas, y con la mayor parte de la actividad de Hopewell terminando en estos sitios alrededor de 1640 ^{14}C aP, o como modelo Bayesiano, *395–430 dC*. Una mayor consideración de la contingencia en el cómputo temporal contemporáneo aumenta la utilidad de las narrativas históricas que nosotros, como arqueólogos, podemos construir.

Keywords: Hopewell; chronometric hygiene; radiocarbon dating; time; classification

Palabras clave: Hopewell; higiene cronométrica; datación por radiocarbono; tiempo; clasificación

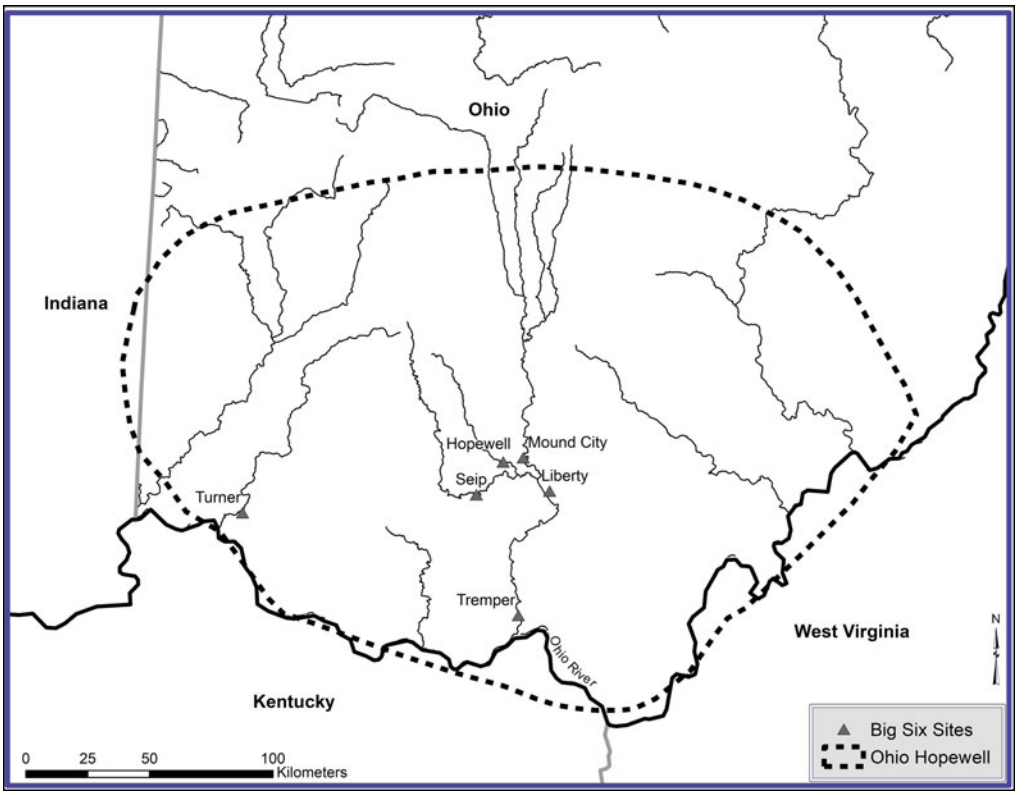

Figure 1. The core area of Ohio Hopewell manifestations (after Griffin 1967). Map by authors.

"Ohio Hopewell" is an archaeological concept that is known worldwide. It represents a climax in the visual and constructional arts in eastern North America approximately 2,000 years ago (Figure 1). Specifically located in southern Ohio, Ohio Hopewell is part of a geographic pattern across the Midwest and Southeast that is termed simply "Hopewell" or "Hopewellian" and characterized by specific object classes and style elements of broad distribution but short duration (Griffin 1967). Ohio Hopewell acts and actions have been interpreted variously as the results of colonization, agriculturally driven social complexity, peer-politic interaction, the control of trade and crafting, and a variety of other social or historical processes.[1] Today, it is perhaps best interpreted as part of an early American Indian socioreligious movement—a reworking of sacred propositions—with distinct shrine or cultic centers (Beck and Brown 2011:73–74, 76). The term "Ohio Hopewell" has been a part of professional archaeology since at least the 1930s, and even before that, the constituent mounds and earthworks were at the heart of the "Mound Builder myth" that drove much of nineteenth-century American antiquarianism (Silverberg 1968).

Today, Ohio Hopewell art and earthen constructions continue to force engagement and bring to the fore questions of heritage, preservation, the deep rootedness of cosmological concepts, and the various potentialities of middle-range societies—sometimes with deeper and more subtle undertones pertaining to race, progress, and the exotic. The archaeological significance of Ohio Hopewell is manifested most concretely in the establishment of Hopewell Culture National Historical Park (HOCU) in 1992, with associated land acquisition, sponsored research, and public history stakeholders. HOCU is a large part of the next UNESCO World Heritage Site listing in the United States (National Park Service 2022). As a result, a protected and interpretable Ohio Hopewell landscape is growing in the twenty-first century, spurred on by the application of a remarkable array of new techniques—geophysical, chemical, and geographical. We would argue that Accelerator Mass Spectroscopy (AMS) dating of

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organic materials, and the careful evaluation of resultant determinations, are important parts of this strong pulse of new knowledge. Time is a key dimension of the Ohio Hopewell narrative.

Time and temporality make a difference in our understanding of accumulated Hopewell history; a narrative that unfolds over 250 years rather than 700 carries different agental possibilities, and at the same time, raises questions as to how we classify a continuous past into meaningful categories of history—and even more generally, how our Western perspective of reckoning time is in reasonable concordance with those of the ancient peoples we study. Notwithstanding these larger issues, we recognize that archaeological time in the Midwest is, in practice, measured in radiocarbon years. Our view of ancient history is therefore conditioned by the accuracy, precision, and replicability of our best practices on this score. For Ohio Hopewell, and as technology has become more available and affordable, the date range has contracted and has become more consistent across estimates (Figure 2). This is further reflected in a recent poll of Ohio Hopewell scholars (Supplemental Text 1).

All radiocarbon dates are not created equal, nor do they always tell us the truth. Or perhaps more properly, sometimes we are ill equipped to understand their truth. Some of the reasons for this radiometric discord are well known: some samples are poorly provenienced, some do not relate to the archaeological event of interest, some samples have considerable inbuilt age, some can suffer from unknown or variable reservoir effects, and some legacy dates were obtained with methods that were less accurate than those available today (Schmid et al. 2019:630). As a result, a variety of protocols have been developed to minimize these effects under the general rubric of "chronometric hygiene" (Rieth and Hunt 2008). AMS dates on short-lived, terrestrial materials are generally privileged in such evaluations, and they also tend to produce somewhat shorter and younger chronologies than those containing many legacy beta-count dates (Fortier et al. 2006:187; Nolan 2012:189, 190, 202; Rieth et al. 2011:2745; Taché and Hart 2013:365, 367; Wilmshurst et al. 2011:1815, 1817).[2] At the same time, we recognize that legacy dates can still contain useful information and, at the very least, provide an important comparative context for evaluation. For this project, we have compiled a dataset of 425 ^{14}C determinations attributed to Ohio Hopewell components in the Middle Ohio River Valley (MORV; Supplemental Table 1 and Supplemental Text 2). We then apply a classification weighing most heavily the most hygienic assays in examining the duration of the general Ohio Hopewell episode as well as the specific histories of the most important sites.

For our first use of the Ohio Hopewell ^{14}C dataset, we have focused on a chronological evaluation of several well-known sites, sometimes referenced as the "the Big Four" (Willey and Phillips 1958:158), or more properly, the "Big Six" (Griffin 1983:261; Shetrone 1930:190)—the Hopewell Mound Group, Liberty, Mound City, Seip, Tremper, and Turner.

Ohio Hopewell and the "Big Six"

Ohio Hopewell sites are distributed along the southerly flowing tributaries of the Ohio River in what is now the state of Ohio (Greber 1998; Griffin 1967; Sieg and Hollinger 2005). Here are found large and complex geometric earthworks, conjoined and elongated mounds, "Great House" submound buildings, puddled clay altars, large and small artifact deposits, ritual fire features, and a variety of regionally specific object forms (e.g., Ross Barbed spears, pottery vessels, copper buttons, effigy boatstones, and metallic breastplates and headplates). There is also a common set of "artistic" stylizations in a variety of media (Seeman 2004; Spielmann 2013), as well as commonalities in measurement and celestial observation not evident in earlier regional complexes (Hively and Horn 2019; Romain 2000). Recent geophysical work suggests that the monumental construction of massive, circular wooden enclosures should be added to this list (Ruby 2019). These are the "touchables and feelables" that give Ohio Hopewell its form. Together they provide a useful but sometimes fuzzy demarcation of the flow of history, and close inspection reveals that many of the characteristic object classes such as rocker-stamped pottery or prismatic blades actually may transcend the temporal bounds of Ohio Hopewell as traditionally recognized, whereas others such as metallic panpipes do not reach these boundaries at all. Rather, such characters follow their own particular sociotemporal pathways producing what Lucas (2015:5–6) calls "imbrication relationships." Consequently, we recognize

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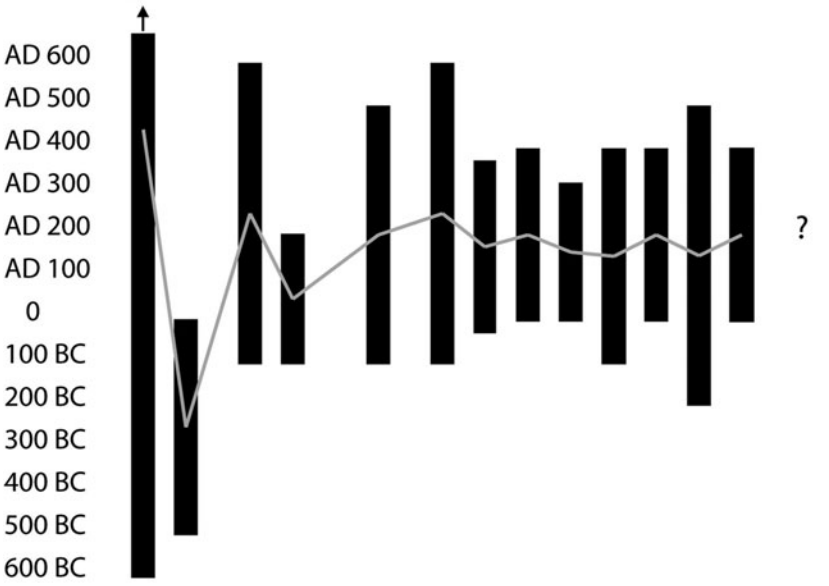

Span	Duration (yrs)	Estimate	Reference
AD 1200-1400	200	1940	Griffin 1952:369
600 BC- AD 1500	2100	1957	Griffin 1974:xiv
500 BC- AD 1	500	1958	Willey & Phillips 1958:158
100 BC- AD 600	700	1964	Prufer 1964:133-135
100 BC- AD 200	300	1966	Willey 1966:273
100 BC- AD 500	600	1978	Fitting 1978:49
100 BC- AD 600	700	1985	Brose 1985:58
50 BC- AD 350	400	1988	Seeman 1988:565
AD 1- 400	400	1992	Seeman 1992:27
AD 1- 350	350	1997	Griffin 1997:413
100 BC- AD 400	500	2004	Byers 2004:2
AD 1- 400	400	2004	Seeman 2004:59
200 BC- AD 500	700	2019	Hively and Horn 2019:117
AD 1- 400	400	2020	Everhart and Ruby 2020:5

Figure 2. Variation in perceptions of Ohio Hopewell duration by decade, AD 1951–2020.

indistinctiveness around the margins of Ohio Hopewell that leads us to narrow our focus to certain key contexts for purposes of the present investigation.[3]

In categorical thinking, certain cases can be seen as more privileged or representative than others. Consequently, for example, Goatly (1997:19) argues that a robin is closer to "birdiness" than a penguin because a penguin cannot fly. Within Ohio Hopewell, six sites since at least the early twentieth century —the Hopewell Mound Group, Liberty, Mound City, Seip, Tremper, and Turner—have conceptually centered the construct. Five of these sites are located in the Scioto Valley of south-central Ohio, and the sixth is located in the lower Little Miami Valley one drainage to the west. All six have yielded elaborate human burials, nonmortuary artifactual deposits, and a variety of architectural details that numerically outstrip the characters present at other presumably contemporaneous sites. For our first use of the Ohio Hopewell ^{14}C dataset, we anticipate little argument in saying that temporally Ohio Hopewell

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is the time when distinctive materials and object classes (e.g., obsidian, Knife River chalcedony, Ross Barbed spears, copper breastplates, effigy platform pipes), monumental geometric earthworks, rectangular clay basins, large ceremonial buildings, and loaf-shaped mounds were being made and used at the Big Six. Brief descriptions of these sites are as follows:

(1) *Hopewell Mound Group (33Ro27)*: This site is located on a terrace above the North Fork of Paint Creek, a small tributary of the Scioto River in Ross County, Ohio. It consists of a massive D-shaped earthwork conjoined with a smaller square, more than 30 mounds, a summer solstice–oriented post circle, an interior embankment structure, submound buildings, offerings, graves, ritual basins, and ancillary residential and production areas. The outer walls enclose 45 ha, but the site is somewhat larger when peripheral loci such as Datum H and Riverbank are considered. The Hopewell Mound Group was first excavated by Squier and Davis (1848); later by Moorehead (1922) and Shetrone and Greenman (1931); and more recently, by a variety of National Park Service investigators (e.g., Pacheco et al. 2012; Ruby 2019; Weinberger and Brady 2010). The Hopewell Mound Group is a unit of Hopewell Culture National Historical Park and is open to the public. We record 43 ^{14}C dates from Hopewell.

(2) *Liberty Earthworks (33Ro22):* The site is located on a terrace of the Scioto River and consists of a geometric earthwork of conjoined circles and a square, plus 14 mounds, ancillary production areas, and at least one large "killed" biface cache. The site covers an area of approximately 38 ha. The center of the largest circle is dominated by the loaf-shaped Edwin Harness mound, which has been excavated many times, initially by Squier and Davis (1848), followed by Putnam (1885), Moorehead (1897), Mills (1907), and most recently by Greber (1983). The Liberty Earthworks are now largely destroyed by agricultural activities. Investigations here have resulted in 38 ^{14}C dates.

(3) *Mound City Group (33Ro32)*: This site is located on a terrace of the Scioto River immediately upstream from the modern city of Chillicothe, Ohio. It was first described in 1808 (Brown 2012:2) and excavated several times by Squier and Davis (1848), Mills (1922), Brown and Baby (1966), and more recently, by Lynott (2015) and others. The site consists of a squarish embankment enclosing an area of 6.3 ha, at least 25 interior mounds, exterior barrow pits, staging areas, manufacturing loci, prepared clay (cremation) facilities, offerings/deposits, secondary and primary burials, charnel houses, and a variety of diagnostic artifact forms, often made of exotic materials. The site was declared a National Monument in 1923 and is today the major interpretive component of Hopewell Culture National Historical Park. We record 27 ^{14}C dates from Mound City.

(4) *Seip Earthworks (33Ro40):* This site is located along Paint Creek, a tributary of the Scioto River. It consists of conjoined circular embankments and square enclosing 49 ha and with walls extending over 3.2 km. There are at least six mounds on the site, including the loaf-shaped Seip-Pricer mound excavated in 1925 and 1928 (Shetrone and Greenman 1931). Eight buildings north of Seip-Pricer have seen considerable recent excavation. Lynott (2015) provides a detailed summary of Seip investigations**.** This site was listed on the National Register of Historic Places in 1974 and is currently a unit of Hopewell Culture National Historical Park. Excavations at Seip have resulted in 18 ^{14}C dates.

(5) *Tremper Works (33Sc4)*: This site is located on a terrace of the Scioto River close to its confluence with the Ohio. It is within 2 km from the source of Ohio Pipestone, a flint clay of importance in the manufacture of smoking pipes for more than 2,000 years. Comparatively, the site is small (1.8 ha), and it consists of a squarish embankment; a conjoined central mound; a large, multiroom submound building; crematory basins; secondary burials; and offerings/artifact deposits. Tremper was first documented by Squier and Davis (1848), excavated by Mills (1916), and listed on the National Register Historic Places in 1972. There are five ^{14}C dates from the Tremper site.

(6) *Turner Earthworks (33Ha26):* This site is located on a terrace of the Little Miami River in Hamilton County, Ohio. Major earthwork features include a circle linked to an oval by a graded

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way and a nearby elongated oval enclosure. It includes 15 mounds, a large lithic workshop and production area, a stone pavement, a separate burial ground, numerous submound buildings, offerings, and individual graves. The site covers approximately 80 ha, most of which has been destroyed by sand and gravel mining. Major excavations were conducted in 1882, 1886, 1889–1890, and 1905 (Willoughby 1922). There are six ^{14}C dates from Turner contexts.

The temporal relationships among the Big Six have been examined previously. This began with a comparison of trait lists (Shetrone and Greenman 1931; Webb and Snow 1945) and was followed by chronologies based on some of the earliest ^{14}C dates (Griffin 1958; Prufer 1968), and even later, examinations of stylistic cross-ties (Seeman 1977), seriations (Ruhl 1996), and obsidian hydration (Hughes 1992; Stevenson et al. 2004). Beyond noting that Tremper is early in the sequence, there is little agreement, prompting (Griffin 1983:264) to state that all such chronology-building efforts were inconclusive, and Lynott (2015:60) to comment that "Ohio Hopewell archaeology suffers from a disarray of radiocarbon results." By assembling a comprehensive dataset and evaluating it from the perspective of temporal hygiene, we begin to unmuddy these waters.

Our Approach

In considering hygienic priorities and constructing analytical classes, we have been governed by four principles following from Napolitano and colleagues (2019:9). First, we recognize that the dispersion among extant Ohio Hopewell dates indicates that both contamination and mis-affiliation have been, and continue to be, problems: many sites are situated on precisely the same well-drained high terraces that were used extensively by earlier and later populations; they have suffered 200 years of intensive Euro-American agriculture, gravel mining, and development; and they have seen hundreds of generations of burrowing mammals, countless tree roots, and few opportunities for natural deposition. This is more of a problem for dating contexts at open sites than for those buried by mound or earthwork fill (see Taché and Hart 2013:365). Second, legacy beta-count determinations with associated large standard deviations are not as precise as those available today due to improvements in laboratory procedures. In this light, we note that Taché and Hart (2013:365) recommend using only dates with standard deviations of less than 60 years, and Siklóski and Szilágyi (2021:24) less than 50 years when constructing chronologies. Similarly, Pettitt and colleagues (2003:1690) discount all dates obtained before 1970, and Blockley and Pinhasi (2011:101) discount them prior to the late 1980s. Third, the "old wood problem" highlights the inbuilt differences in organic materials that privilege short-lived plant materials or terrestrial animal bone for dating—especially, in our case, the annual plants of the Eastern Agricultural Complex (Napolitano et al 2019:9; Nolan 2012:187–188; Taché and Hart 2013:365, 367). Against this reality must be balanced the fact that many Ohio Hopewell architectural constructions of key concern were built with long-lived oak and hickory wood, not annual plants or bone. Finally, a poll of Hopewell specialists makes it clear that "Ohio Hopewell" in current practice lies somewhere within the interval 2050–1500 ^{14}C years BP (Supplemental Text 1). We follow Wilmshurst and colleagues (2011:1815) in using this poll of subject experts to establish an initial broad window in order to exclude modern or other implausible dates.

With the above in mind, we have collected information on 425 ^{14}C dates from contexts identified as Ohio Hopewell (Supplemental Table 1; Supplemental Text 2). We then define seven analytical classes based on chronometric hygiene criteria and association with cultural materials of interest (for a similar treatment of association, see Krus 2016), and we identify each date with one of these classes. Subsequent to classification, we examine and interpret resultant patterning. Our analysis focuses mainly on radiocarbon years as a measure of time and as the results of primary laboratory analysis, although we also will examine in limited fashion the effects of calibration and Bayesian modeling. Our hygienic classification is as follows:

Class 1: AMS dates derived from samples of short-lived nuts, seeds, fibers, terrestrial bone, or bark having clear associations with diagnostic artifacts and/or sealed within Hopewell mound or embankment contexts; standard deviations equal to or less than 60 ^{14}C years.

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Class 2: AMS dates derived from carbonized wood or unspecified charcoal having clear associations with diagnostic artifacts and/or sealed within Hopewell mound or embankment contexts; standard deviations equal to or less than 60 ^{14}C years.

Class 3: Beta-count (conventional) dates on organic materials—generally carbonized wood—with clear diagnostic associations and/or sealed within Hopewell mound or embankment contexts; standard deviations equal to or less than 60 ^{14}C years and assayed after AD 1970.

Class 4: Dates with clear diagnostic associations and/or sealed within mound or embankment contexts with standard deviations greater than 60 ^{14}C years. Included here are many pre–AD 1970 legacy beta-count dates.

Class 5: Dates from nonmound or nonembankment contexts where diagnostic associations are unspecified, unclear, or unknown. Generally, these are postholes in open, unstratified habitation sites with prominent Hopewell components.

Class 6: Dates outside the range 2050–1500 ^{14}C years BP. We assume these dates pertain to other, non-Hopewell components, although clearly investigators thought (or hoped) they would pertain to ancient Ohio Hopewell activities at the time samples were taken.

Class 7: Dates with incomplete provenience or sample information that preclude any other classification at this time, plus all the dates from the Dicarb Radioisotope Co. (see below). For one date in this category we can do little more than to confirm its probable existence.

The 425 dates in our Ohio Hopewell dataset represent measurements by 17 different laboratories (Supplemental Table 2). Historically, they include three of the earliest ^{14}C determinations ever made by Willard Libby at the University of Chicago lab as well as AMS dates obtained within the last few years. Beta Analytic Inc. (Beta) is by far the preferred laboratory for Ohio Hopewell archaeologists and has produced two-thirds (284/425 = 67%) of the determinations in our compilation. The University of Georgia (UGAMS) is a second (40/425 = 9%). We assume that dates from these 17 laboratories are comparable (see Boaretto et al. 2003:151, 154; Scott et al. 2010:863–865) according to the seven criteria specified above, with one exception. The comparability of dates from Dicarb Radioisotope Co. (Dicarb) to all others in our analysis has been questioned (Reuther and Gerlach 2005). To this we add the facts that the Dicarb dates at a local Ohio Valley site indicate a similar discrepancy (Shott 1992), and that the lab director, Irene Stehli, told one of us (Seeman) that she had a problem with the oxalic acid standard for a number of dates run in the 1980s and offered to provide correction equations. For these and other reasons, and for purposes of the present study, we have placed all Dicarb dates in our Class 7.

Finally, and following from Lynott (2015:174), we have chosen to average the three AMS dates on a rare material (pine charcoal) from what is considered "a brief burning episode" in the southeast barrow pit at Mound City in our analysis. These are among the most recent Ohio Hopewell dates from the Big Six—1590 ± 40, 1630 ± 40, and 1720 ± 40 ^{14}C years BP, respectively. It should be noted that Mound City has seen intensive disturbance and modification due to the construction and use of Camp Sherman, a World War I training facility placed squarely on this Ohio Hopewell site.

Although we see uncalibrated ^{14}C assays as useful comparative measures, it has been shown since at least 1958 that radiocarbon years can be calibrated in order to better estimate their placement in Gregorian time. For the current investigation, we have used the most recently available calibration—IntCal20 (Reimer et al. 2020) and Bayesian analytical functions in OxCal 4.4 (Bronk Ramsey 2009a)—to construct various models for each site as well as a combined Ohio Hopewell sample, (a) including all dates without outlier analysis (Bronk Ramsey 2009b), and (b) incorporating outlier analysis. Where acceptable agreement cannot be achieved, we have removed dates that are poor fits with the respective models. We further recognize that calibrations since their inception have themselves been subject to change and therefore provide something of a moving target. In addition, presumed increases in accuracy do not necessarily equal increases in precision. With regard to the former and with direct relevance to the Hopewell episode, we note reported differences of 50 years circa 1900–1700 cal BP between IntCal20 and its immediate predecessor, IntCal13, in a test case (Staff and Liu 2021:1–2). Calibrated and modeled years are not the same as radiocarbon years, nor for that matter are they the same as solar years or sidereal years—or defining spring as beginning when a red oak leaf is

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the size of a mouse's ear. However, all are acceptable, complementary, and useful measures of time under given circumstances. In sum, after evaluating Classes 1–7 of ^{14}C assays comparatively, we will combine and/or exclude classes for purposes of modeling a more hygienic Ohio Hopewell chronology. We report and compare our findings in both radiocarbon years and as calibrated and modeled to approximate familiar calendar years.

Findings

Comparative summary statistics for our constructed classes of Ohio Hopewell ^{14}C dates provide insights for hygienic consideration (Table 1). The seven class mean ages range between 1653.1 ^{14}C years BP and 1832.0 ^{14}C years BP. Excluding Class 7, the range of central tendencies is reduced by 135.5 ^{14}C years. Classes 1–5 show relatively consistent medians, with Class 6 and Class 7 as outliers —particularly Class 6. The within-class variability of the ^{14}C years BP age estimates (σA in Table 1) shows Class 1 as the most internally consistent (σA = 78.1), followed by Class 3 (98.3), then Class 2 (108.3). The scale of difference in dispersion within classes is relatively consistent between Class 2 and Class 4 ($_{\Delta}$σA = 19.3) and between Class 4 and Class 5 ($_{\Delta}$σA = 22.8). Class 6 and Class 7 dates exhibit extreme variability (σA = 1171.0 and 242.1, respectively). Classes 1–3 have precision estimates that are very consistent within each class (σB in Table 1; Figure 3), with a qualitative leap in the variability of precision estimates for Classes 4–6, and again for Class 7. Given these findings, we argue that better quality dates can be found in Classes 1–3 than in Classes 4–7 for purposes of refining the current Ohio Hopewell chronology. In short, they show the least internal variability and the most precision. We now turn our attention more specifically to Classes 1–3 in incremental fashion as they affect our estimate of the span and placement of the general Ohio Hopewell episode as well as the Big Six individually.

Table 2 shows comparatively descriptive statistics for dates in Classes 1–3, now limited to dates from just the Big Six and added incrementally into more inclusive sets based on our assumptions of utility. Set 1 (Class 1 only) shows the least variation of the three sets, both in terms of assayed values and among their associated standard deviations (Table 2 σA and σB). This group also has, on average, the youngest values when sites with more than one radiocarbon date are considered. The resultant sample size for Set 1 dates (n = 31) is small, leaves half the sites with less than three assays, and limits our interpretations: first, Mound City shows earlier usage and a longer span than Liberty or Hopewell, and second, the duration of the Ohio Hopewell episode using the best-quality dates is only 220 radiocarbon years—1660–1880 ^{14}C years BP. This is shorter than traditional estimates for the Ohio Hopewell episode by half, and it is much shorter than the span of Class 1 dates for the entire population. However, the quartile ranges are more similar (1710–1815 versus 1720–1830 ^{14}C years BP), especially for the younger end, indicating that there may very well be legitimate Ohio Hopewell contexts prior to 1880 ^{14}C years BP. The average standard deviation from each Set 1 assay is 31.1 ^{14}C years (σB Mean in Table 2).

Table 1. Comparative Values for Seven Classes of Radiocarbon Dates in Ohio Hopewell Dataset.

Class	*N*	Min.	Q_1	Median	Q_3	Max.	Mean	σA[a]	σB[b]	Mean σB
1	55	1640	1720	1790	1830	1990	1788.6	78.1	8.3	28.1
2	91	1540	1755	1840	1900	2020	1826.0	108.3	6.5	39.2
3	45	1555	1740	1810	1850	2020	1801.0	98.3	6.1	56.1
4	84	1510	1750	1827	1923	2050	1832.1	127.6	38.1	95.3
5	33	1510	1730	1810	1910	2180	1810.8	150.4	25.1	64.7
6	80	20	1008	2085	2345	5130	1779.0	1171.0	34.2	67.2
7	29	1110	1520	1680	1770	2150	1653.1	242.1	97.8	94.5

Note: Table values are Radiocarbon Years before Present (RCYBP). Three Class 2 cases from Mound City, southeast barrow pit averaged, see p. 174. Four cases from Class 6 and two from Class 7 omitted because of incomplete data or "modern" values.

[a] σA = standard deviation of dates in class.

[b] σB = standard deviation of the standard deviations as reported by laboratories for all dates in each class.

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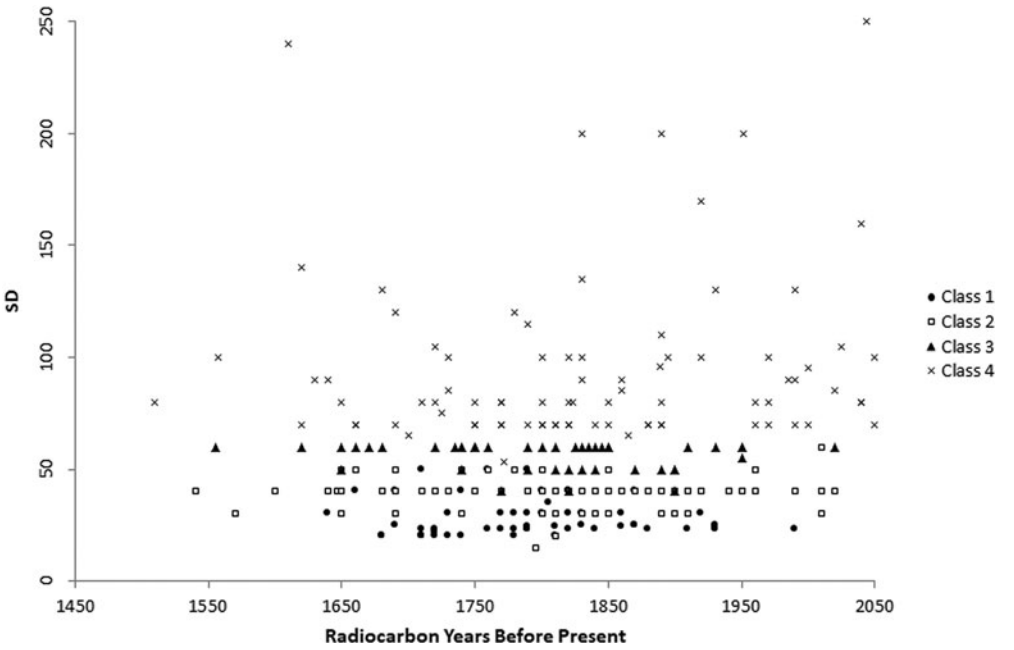

Figure 3. Plot of Ohio Hopewell Class 1, 2, 3, and 4 ^{14}C assays by their individual standard deviations.

By relaxing our hygiene criteria to include Class 2 dates (AMS assays, good context, carbonized wood, long-lived plants) along with Class 1 dates into a Set 2, we double the size of the Big Six sample (Table 2). Now, all but Tremper have more than five dates (there are only five total dates from Tremper of any kind). The overall mean of Set 2 is slightly older (11 ^{14}C years) than that of Set 1, and the associated variance of age estimates is consistently greater (σA in Table 2), indicating some loss of precision. However, average uncertainty only increases by 5.0 ^{14}C years (σB Mean in Table 2). Set 2 dates document temporal relationships that are somewhat different, and presumably clearer, than those possible using Set 1 dates alone. Notably, the duration of the Ohio episode increases by 150 ^{14}C years, or to a total of 370 ^{14}C years. This range (2010–1640 ^{14}C years BP) is consistent with the range that archaeologists have traditionally considered (Supplemental Text 1). Regarding specific sites, Tremper has the oldest mean of the Big Six—1935 ^{14}C years BP. Mound City has the second-oldest mean, 1824 ^{14}C years BP, and the maximum age estimate, but still carries the broadest standard deviation of any site under consideration (σA in Table 2). This could be measurement errors, or as noted for Set 1, a longer use span. The Hopewell Mound Group, Liberty, Seip, and Turner provide ^{14}C records that are more similar to one another, with Seip showing the largest percentage of late dates. A clear pattern is the relatively sudden termination of site use at approximately 1650 ^{14}C years BP for five of the six sites.

By further relaxing our hygienic criteria to include Class 3 dates (standard beta-count dates, standard deviations less than 60 ^{14}C years, generally on carbonized wood), we increase the Big Six sample by only 8% (5/61 = 8%) over that of Set 2, but the sample size of Liberty and Seip by 17% and 18%, respectively. The inclusion of these dates results in a slight increase in average uncertainty associated with each assay by 1.5 ^{14}C years to 37.5 ^{14}C years (σB Mean in Table 2). The estimated maximum Ohio Hopewell episode remains as it was under the previous conditions—2010–1640 ^{14}C years BP—but the quartile range increases by eight ^{14}C years. Once again, Tremper and some contexts at Mound City are clearly earlier than those at the other four sites (Figure 4). The mean of the two dates at Tremper is still the earliest, and Mound City the second earliest. Mound City still shows the longest span as a historic Ohio Hopewell place, and Tremper the shortest. The end of Ohio Hopewell is consistent across five of the six sites at approximately 1650 ^{14}C years BP, with Seip providing the latest dated contexts.

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Table 2. Descriptive Statistics for Increasingly Inclusive Sets of Hygienic ^{14}C Dates by Site.

Set 1 (Class 1 only)	*N*	Min.	Q1	Median	Q3	Max.	Mean	σA[a]	σB[b]	σB Mean
Hopewell	12	1690	1710	1750	1793	1870	1758	55.2	5.9	26.7
Liberty	7	1660	1705	1760	1785	1820	1746	58.3	9.4	36.4
Mound City	8	1680	1725	1815	1840	1870	1788	77.8	8.9	28.8
Seip	1	1805	1805	1805	1805	1805	1805	—	—	—
Tremper	1	1880	1880	1880	1880	1880	1880	—	—	—
Turner	2	1710	1730	1750	1770	1790	1750	56.6	0.0	50.0
All	31	1660	1710	1770	1815	1880	1768	63.7	9.8	31.1
Set 2 (Classes 1 & 2)										
Hopewell	22	1660	1710	1765	1800	1960	1768	77.0	10.7	35.0
Liberty	12	1650	1713	1765	1803	1870	1758	67.3	10.5	34.2
Mound City	13	1647	1740	1830	1890	2010	1824	110.3	8.9	33.1
Seip	6	1640	1668	1760	1804	1840	1743	85.2	3.8	37.5
Tremper	2	1880	1908	1935	1963	1990	1935	77.8	8.5	31.5
Turner	6	1650	1718	1760	1788	1850	1753	69.5	0.0	50.0
All	61	1640	1710	1780	1830	2010	1779	89.6	10.3	36.0
Set 3 (Classes 1, 2, 3)										
Hopewell	23	1660	1710	1770	1810	1960	1771	77.2	11.6	36.1
Liberty	14	1650	1728	1783	1818	1950	1777	81.8	12.8	37.5
Mound City	14	1647	1695	1825	1885	2010	1813	112.7	11.0	35.0
Seip	7	1640	1685	1770	1803	1840	1746	78.5	3.6	37.9
Tremper	2	1880	1908	1935	1963	1990	1935	77.8	8.5	31.5
Turner	6	1650	1718	1760	1788	1850	1753	69.5	0.0	50.0
All	66	1640	1710	1780	1838	2010	1782	90.1	11.3	37.5

[a] σA is standard deviation of assayed values.
[b] σB is standard deviation of the standard deviation reported with each assayed value.

Finally, it is useful to briefly consider the effects of calibration and Bayesian modeling, focusing on the combined sample of Set 3. Here we consider a total of seven models, six for the individual sites considered separately, and then bundling all 66 Set 3 dates into an Ohio Hopewell single-phase model, all using the Bayesian modeling tools of OxCal 4.4 (Bronk Ramsey 2009a). Results are presented in Table 3, and the coding and procedures are described in Supplemental Text 3, Supplemental Table 3, and Supplemental Table 4. Six of the seven models (all assays equal, no internal structure) have model and overall indexes above the critical value. Liberty is the exception, and here only the A_{model} Index was satisfactory (Liberty A_{model} Index = 70.5, Liberty $A_{overall}$ Index = 52.7). Consequently, Liberty was remodeled using two outliers models for the two dates with low agreement with the original model—in this case, two assays from the central Edwin Harness mound (Beta-145873 and UGA-2419). Assay UGA-2419 was wood charcoal and, following Bronk Ramsey (2009b), we employed a Charcoal outlier model. For Beta-145873 we used a Palimpsest outlier model given that the measurement was too young (Supplemental Text 3). The outlier-modeled Liberty phase produced the satisfactory model reported.

Considering the site models first, the Hopewell Mound Group, easily the most structurally complex of the six under consideration (Seeman 1979:302, 307), covers a relatively brief Span—only *215* calibrated and modeled years when compared to a range of 370 uncalibrated radiocarbon years (Tables 2

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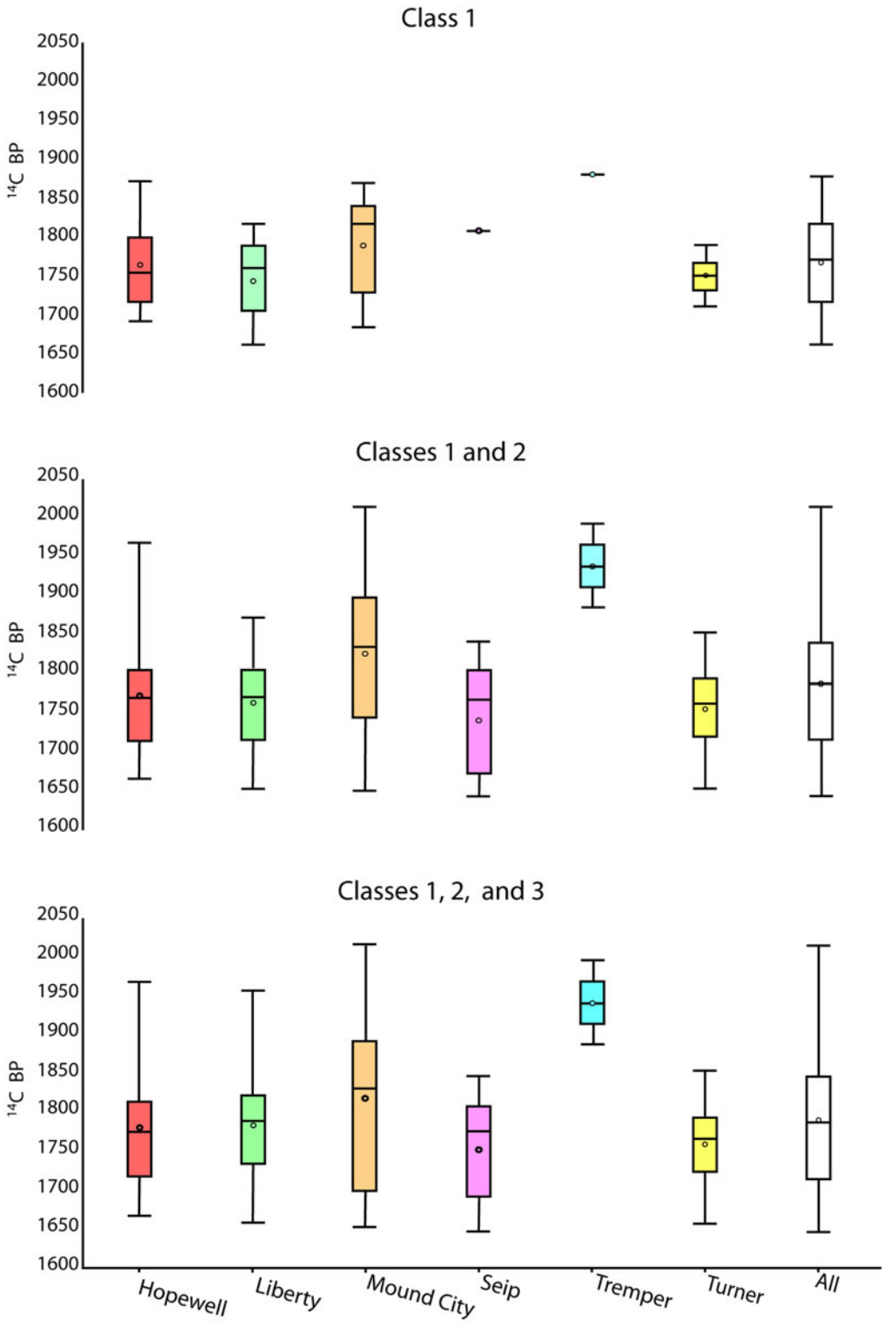

Figure 4. Boxplots showing increasingly inclusive sets that combine the three most hygienic classes of ^{14}C dates for six Ohio Hopewell sites.

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Table 3. Single-Phase and Individual Site Models for Set 3 (Classes 1–3), Ohio Hopewell ^{14}C Dates.

	Single-Phase	Hopewell	Liberty[a]	Mound City	Seip	Tremper	Turner
N of Dates	66	23	14	14	7	2	6
A_{model} Index	79.6	85.6	66.7	91.4	91.6	92.4	83.9
$A_{overall}$ Index	61.9	81.9	61.3	88.9	86	92.4	84.6
Start min hpd[b]	*90 (36.2)*[d]	*150 (68.3)*	*185 (68.3)*	*1 (68.3)*	*170 (68.3)*	*−255 (67.6)*	*190 (68.3)*
Start μ	*125*	*170*	*215*	*40*	*205*	*−205*	*225*
Start σ	*30*	*30*	*35*	*55*	*70*	*315*	*75*
Start med	*125*	*180*	*220*	*45*	*215*	*−85*	*235*
Start max hpd[c]	*120*	*205*	*245*	*105*	*295*	*125*	*310*
End min hpd	*395 (68.3)*	*365 (68.3)*	*260 (68.3)*	*385 (68.3)*	*355 (68.3)*	*115 (68.3)*	*285 (68.3)*
End μ	*410*	*390*	*330*	*430*	*430*	*380*	*375*
End median	*415*	*390*	*325*	*425*	*425*	*380*	*365*
End max hpd	*430*	*420*	*355*	*460*	*500*	*445*	*420*
End σ	*15*	*25*	*45*	*45*	*80*	*245*	*80*
Span min hpd	*245 (68.3)*	*170 (68.3)*	*25 (68.3)*	*305 (68.5)*	*60 (68.3)*	*0 (67.8)*	*0 (58.3)*
Span	*285*	*215*	*115*	*390*	*225*	*580*	*150*
Span σ	*35*	*45*	*70*	*80*	*125*	*490*	*130*
Span max hpd	*330*	*255*	*150*	*455*	*300*	*660*	*185*

[a] with outlier modeling
[b] minimum hpd = shortest interval among all Bayesian credible intervals
[c] maximum hpd = longest interval among all Bayesian credible intervals
[d] model resulted in a bimodal probability distribution with 68.3% probability (1σ) being split into two mutually exclusive ranges: AD 90–120 (36.2%), AD 130–170 (32.1%) with a 95.4% range of AD 70–185.

and 3). Liberty covers even less time—*115* calibrated and modeled years—whereas the distribution of uncalibrated dates is longer and looks very similar to the Hopewell Mound Group (Tables 2 and 3). Mound City in comparison to the above has a much longer Span than either the Hopewell Mound Group or Liberty, with the earliest mean start date and latest mean end date of the three. The modeling of Mound City as long lived is consistent with the relative placement of the site in uncalibrated radiocarbon years. The temporal placement of Seip relative to the Hopewell Mound Group, Liberty, and Mound City is likewise similar to that obtained with uncalibrated radiocarbon dates; consequently, Seip starts at about the same time as Liberty and a bit later than the Hopewell Mound Group but lasts longer than either. The Tremper model provides index scores that indicate a good model, but it is based on only two dates, and the results are not useful for our purposes. Turner, the last site under consideration, shows the latest mean start date and ends within *55* modeled years of four of the other five sites, although comparatively, not as late as is implied by the uncalibrated radiocarbon dates. As calibrated and modeled, there is still reasonable congruence for the end use of five of the six sites, although this correspondence is not as precise as implied by a consideration of age based on radiocarbon years alone. The seventh model bundles all 66 radiocarbon dates into a single Ohio Hopewell phase as a coherent cultural phenomenon. The model fit ($A = 79.6$) and the overall fit ($A = 61.9$) are above the critical threshold ($A \geq 60$), despite three dates exhibiting a poor fit with the model (Beta-115625, Beta-253201, ISGS-5645). Results indicate a mean start date of *125 ± 30 AD*, a mean end date of *410 ± 15 AD*, and a Span of *285 ± 35* calibrated and modeled years.

The main substantive finding resulting from the calibration and Bayesian modeling our data is that the entire Ohio Hopewell span is only *285 ± 35* calibrated and modeled years, with a minimum Bayesian credible interval beginning *AD 90–120* (36.2 hpd) and ending *AD 395–430* (68.3 hpd).

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This would seem to be a briefer span than would be concluded by measuring time in radiocarbon years alone, although strictly speaking, this is not a fair comparison (Tables 2 and 3). Perhaps fairer is comparing these results with the span and placement of the Hopewell episode by a survey of practitioners (Supplemental Text 1). Here again, the modeled data shows a shorter span and a notably younger range in Gregorian calendar years than is commonly recognized—*285* calibrated and modeled years versus 350 calendar years, and beginning *AD 90–120* versus AD 1. In sum and as modeled, Ohio Hopewell begins later than is sometimes recognized, four sites have a mean end date within 55 years of one another, Tremper and Mound City begin earlier than the other sites, Mound City shows the longest span of continuous use, and the few high-quality dates from Tremper minimize the utility of modeling the timing of this site.

Interpreting Findings and Ohio Hopewell Chronology

By focusing on those three classes of ^{14}C determinations that we assume to be of the most acceptable quality, we have utilized 16% (66/425 = 16%) of the interpretable sample and 50% (66/131 = 50%) of the available dates for the Big Six. Together, they provide an Ohio Hopewell chronology that is reasonably interpretable. By way of comparison, Taché and Hart (2013:360) used only 16% of the available assays in their study of Vinette 1 pottery, and Wilmshurst and colleagues (2011:1817) used only 14% in their research on Polynesian colonization. That is not to say, however, that even good-quality dates will not vary, and inclusion or exclusion of classes changes the details of the narrative somewhat. As modeled, the general temporal relationship among sites appears similar but differs in details, most notably, on the shorter and overall younger estimation of the temporal span. Time in radiocarbon years offers the advantage of stability and hence comparability among dates—especially in a region where comprehensive chronologies based on Bayesian modeling are not yet widely available—whereas modeled data provides the advantage of better approximating Gregorian time, evermore closely with each newly improved model.

Our summary assessment is that Mound City and Tremper are the earliest of the Big Six centers, with reliable dates circa 2000 ^{14}C years BP but that calibrate and model somewhat later. The floor deposit at Tremper may be the scene of the earliest large-scale Ohio Hopewell ritual events given that Class 1 and Class 2 AMS dates from the Tremper mound floor are slightly earlier than any of the Class 1 and Class 2 dates from the two best-dated mounds at Mound City—specifically, Mound 10 and Mound 13. This early position of Tremper fits with most previous analyses based on stylistic and trait list similarities (e.g., Prufer 1968:148–149; Ruhl 1996; Seeman 1977; Shetrone and Greenman 1931:493; Webb and Snow 1945:204–217; see also Gehlback 1988), and also, with gorget and pipe styles from Tremper that occur in early Havana Hopewellian contexts to the west (Farnsworth 2004:414; Farnsworth et al. 2016; Meinkoth 1995:55; Tankersley et al. 1990:223–224). At Tremper, in contrast to Mound City, most of the platform pipes were made of exotic western Illinois Sterling pipestone and Minnesota catlinite, and they equally mark the introduction of new platform pipe styles with deeper temporal roots in the Illinois Valley (Emerson et al. 2013; Farnsworth et al. 2021). The large physical size of crematory basins at both Tremper and Mound City (when compared with earlier individual inhumations and, later, smaller Hopewell basins) and their associated secondary cremains and offerings indicate that rituals and their presumed tie to community identities were probably broadening at this early time, as does the increased value placed on extraregional preciosities worked into objects of consistent style. Cultic innovations and wide-scale reinterpretations are key aspects of American Indian religiosity historically, and we see no reason why such patterns would not extend into deep time (see Hall 1997). The ceramics at Tremper also are unique among the Ohio Hopewell centers (Stoltman 2015:3, 55).

Mound City clearly covers much more time than Tremper based on available best-quality ^{14}C dates. The dates from the North 40 area at Mound City to the north of the earthen walls represent as a group the earliest dates from a Big Six context (Everhart and Ruby 2020), and dates from the southeast barrow pit are some of the latest (Supplemental Table 1). As noted above, some dates from Mound 10 and 13 are relatively early, and artifactual cross-ties between undated Mound City Mound 8 and Tremper suggest even closer temporal proximity (with due appreciation to prospects of style lag and/or later

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emulation). More specifically, the tight stylistic similarities of the dated effigy platform pipes from Mound City Mound 8 and Tremper are well recognized (Brown 2012:301; Emerson et al. 2013:60; Prufer 1964:47). To drill down on this relationship more specifically, we note effigy pipes from Tremper and Mound City Mound 8 where the animal effigy faces perpendicular to the platform (Mills 1916:328; Squier and Davis 1848:271). This is in contrast to the near universal depiction on Hopewell pipes from other Ohio Hopewell sites, on which effigies face the smoker. Similar sideways-facing examples occur in several early Illinois Hopewellian contexts, and the single AMS date of 1908 ± 16 ^{14}C years BP (cal AD 140 ± 40) from Naples-Russell Mound 8 in western Illinois (Farnsworth and Atwell 2015:121, 181) is quite consistent with the early dates from Tremper. A remarkably styled toad pipe further ties Mound City Mound 8 to the Naples-Russell Mound 8 date (Farnsworth and Atwell 2015:174–175) and, by extension, to Tremper.

By way of cross-ties to Mound City, two additional Hopewellian dates from Illinois must be considered. Elizabeth Mound 7 in the lower Illinois Valley yielded a standard date on white oak charcoal of 1940 ± 70 ^{14}C years BP (Leigh et al. 1988:70) and another of 1940 ± 15 ^{14}C years BP (Farnsworth and Atwell 2015:196). Their relevance lies in the dating of specific forms of Hopewellian Gulf Coast bird symbolism—specifically, the "hooked tail" motif and "stubby body" forms—which tie Elizabeth Mound 7 and Naples-Russell Mound 8 in Illinois with Mound City Mound 1, Mound 2, and Mound 8 in Ohio and, farther afield, to the Crooks site in Louisiana (Brown 2012:243; Farnsworth and Atwell 2015:138, 175–178; Ford and Willey 1940:66–71; Morgan 1988:144). In sum, although the available good-quality dates from Mound City cover a considerable span, cross-ties to dated contexts elsewhere suggest somewhat more intensive use toward the earlier period of Ohio Hopewell mound building. This evaluation is consistent with Brown's (2012:248) conclusion that the ceramics from Mound City are relatively early in the Ohio Hopewell sequence.

Although both Tremper and Mound City have simple earthen enclosures, those at the Hopewell Mound Group, Liberty, Seip, and Turner are larger and more complex, with the appropriate developmental implications. Of these four, the Hopewell Mound Group covers the longest temporal span in ^{14}C years, but after Bayesian modeling, Seip and the Hopewell Mound Group appear more similar—Spans of *215* and *225* modeled years, respectively. Duration at such sites can be measured not only as sequential events but in the historical life of buildings and heirlooms as they enter later contexts. Consequently, for example, within Hopewell Mound Group Mound 25, the Set 1 (Class 1 only) dates from Burial 11 and Burial 41 are separated by 90 ^{14}C years with nonoverlapping standard deviations. Similarly, the two Class 2 dates from Burials 260–261 above the floor of Hopewell Mound Group Mound 25 span even more time. Burials 260–261 are noteworthy in that "the mass of material deposited with them exceeds that associated with any other burial so far discovered in the United States" (Moorehead 1922:110). A similar span of dates occurs with materials associated with Hopewell Mound Group Mound 25, Altar 1 (Supplemental Table 1). These examples support the interpretation that certain public rites carried with them the use of ancestral materials with retained animacy over time, and/or that the use life of particular ritual spaces sometimes unfolded across several generations of practitioners (Seeman 2020:325–326).

Regarding Liberty, the most important finding is that by demoting the Dicarb dates to Class 7, the site falls much more in line with chronological expectations when compared with other centers and does not extend Ohio Hopewell nearly as late as implied by these determinations. Although it is notable that Liberty and Seip bear a number of strong constructional similarities, Seip provides the later series, primarily because activities there continued after those at Liberty had ended. The ending of activities at Seip circa 1640 ^{14}C years BP, or *355–500 AD* as modeled, is consistent with the presence of certain object stylizations, including steatite Copena-style pipes and also plummets similar to those found at Crystal River, Cincinnati, and Mann Mound 3 (Thompson et al. 2017:202). The six Turner dates, although a small sample, suggest that site differences when compared to Scioto Valley centers may have more to do with distance than time, contrary to previous discussions based in large part on artifact styles that have placed Turner as the latest of the major site centers (Prufer 1968:148–149; Ruhl 1996).

Finally, it is worth emphasizing that although available high-quality ^{14}C determinations from the Hopewell Mound Group, Liberty, Seip, and Turner show considerable overlap and a relatively

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synchronous ending, overlap should not be confused with exact contemporaneous usage and/or interaction—something that is very difficult to demonstrate given our current dating tools in the American Midwest but that bears directly on the two main competing social models of Ohio processes deemed the proximity and synaptic models, respectively (Nolan et al. 2020:151).

Conclusions

When is Ohio Hopewell? The answer lies in how time is reckoned, which is in large part determined by the quality of the ^{14}C determinations that are deemed acceptable, and the specific calibration and modeling programs that are used. The present study has examined some of these complexities and their implications, and in the process, we confront the negotiable nature of time itself as we attempt to bend it to our purposes (see Hawking 1988; Holdaway and Wandsnider 2008; Lucas 2005). We recognize that our own struggle with such issues is not unique, and that is further complicated by the changing viewpoints used to define and interpret Ohio Hopewell over its hundred-year history of use. The *when* of Hopewell always has been tied to the *what* and the *why* of Hopewell in complex fashion. Consequently, for example, in the 1950s, when Ohio Hopewell was thought to have lasted for 2,000 years, the notion of gradual colonization from a motherland might have made sense. Today, we know the time frame is much shorter, but how much shorter depends on how we sample and interpret the available ^{14}C dates. Our approach here foregrounds the variable quality of dates in our dataset and the contingent nature of temporal interpretations. As long as we find the Hopewell concept useful, we must regularly revisit the dating of its touchable, feelable, and sortable characteristics with new techniques and new approaches. The same holds true for other enduring archaeological concepts such as Olmec and Chavin in the Americas, Bell Beaker and Bandkeramik in Europe, and Natufian and Jōmon in Asia. These are all "fuzzy sets" that recognize degrees of membership and/or the assessment of elements that have each performed a delicate dance of what, when, and why across the decades. The present study indicates that Tremper and Mound City are somewhat earlier than the other four major Ohio Hopewell sites under consideration, that Mound City is the most enduring, that Turner is no later than the other centers, and that there was a relative sudden ending to the practices we identify with these places. Reasonable estimates for the Ohio Hopewell episode are 2010–1640 ^{14}C years BP and beginning *AD 90–120* and ending *AD 395–430* as calibrated and modeled.

Our concern here with temporal hygiene simply recognizes in formal terms that some dates are "worse than" or "better than" in constructing a past. An appreciation of such contingency produces chronologies that may look messy when compared to the crisp slices of time that were produced in the 1960s to 1990s. This reality should not go unappreciated when we tell our public that ^{14}C dates provide "absolute dates for the past 40,000 years" (Feinman and Price 2010:145), or that "the actual measurement of radiocarbon is straightforward" (Feinman and Price 2010:146), or that radiocarbon dates can now be "correctly converted to calendar years" (Feinman and Price 2010:146). Furthermore, we should perhaps contemplate the extent to which such claims may be, or may have been, tied to our own professional identities. In sum, available data and a critical, hygienic approach suggest that Ohio Hopewell religious practices provided shorter-term satisfaction and stability than previously recognized.

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Data Availability Statement. Primary dataset and OxCal code used are in Supplemental Text 3, Supplemental Table 3, and Supplemental Table 4.

Competing Interests. The authors declare none.

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Supplemental Material. For supplemental material accompanying this article, visit https://doi.org/10.1017/aaq.2023.6.
Supplemental Text 1. Blind Poll of Ohio Hopewell Scholars on Temporal Span and Placement.
Supplemental Text 2. References for Ohio Hopewell ^{14}C Dataset.
Supplemental Text 3. Descriptive Guide to OxCal Calibration and Modeling Inputs and Outputs.
Supplemental Table 1. Ohio Hopewell ^{14}C Dataset.
Supplemental Table 2. Ohio Hopewell ^{14}C Dates by Laboratory.
Supplemental Table 3. Coding for All Assays Used in OxCal Modeling.
Supplemental Table 4. OxCal Results.

Notes

1. Although the substance of Ohio Hopewell has remained fairly constant through the years—massive geometric earthworks, mounds with submound building, crafted objects of standardized form often made of exotic materials, mass burnt offerings of preciosities, elaborate funerary rites—Ohio Hopewell has been interpreted in various ways. Historically, it has been regarded as the center of an early culture extending across eastern North America (Shetrone 1930), as a node on a larger Hopewell Interaction Sphere centering on ideology (Caldwell 1964) and/or economics (Struever and Houart (1972), and most recently, as a religious reworking of ultimately sacred propositions (Beck and Brown 2011). Ohio Hopewell was a well-defined "aspect" in the Midwest Taxonomic Method and contrasted with most other (lesser) regional manifestations termed "Hopewellian" (Griffin 1967:181, 183–187). Carr (2005), Seeman (1979), and Sieg and Hollinger (2005) provide details on concept development (see also Van Gilder and Charles 2003).
2. These "on the ground" differences are of interest in light of test results that show that beta count (LCS) and AMS dates produce very comparable results under controlled conditions (Kim et al. 2016:7–8, 12; Ronald Hatfield, personal communication 2021).
3. Miller (2018) dates a single artifact class—the prismatic blade—and assumes it dates the Ohio Hopewell episode. Bladelets may extend in time somewhat beyond the bounds of Ohio Hopewell temporally and into the Newtown phase of the Late Woodland period (Pollack and Henderson 2000:627; Seeman and Dancey 2000:589; see also Kimball et al. 2010; Redmond and McCullough 2000; Stezewski 2014), something Miller notes in later work (2020:239).

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