A PRELIMINARY EXAMINATION OF FRESHWATER BIVALVES AT THE LATE PREHISTORIC HAHN SITE, NEAR CINCINNATI, OHIO

Robert A. Genheimer and Stanley E. Hedeen

Abstract

Freshwater bivalves recovered from two trash-filled storage pits excavated at the Late Prehistoric Hahn site near Cincinnati, Ohio are analyzed. The nature of these two deposits suggests that they were probably single episode discards related to post processing of mussels as a food resource. A total of 26 species was identified for the combined feature assemblages. While small to medium-large species were collected, five individual species of small, medium, and medium-large mussels accounted for nearly three-quarters of the mussel sample MNI. A comparison to recently surveyed mussel populations illustrates that mussel diversity in the Little Miami River near Hahn has declined significantly historically, with those species sensitive to sedimentation and turbidity either found in low numbers or extirpated. Despite the large number of bivalves and bivalve fragments recovered from Hahn only a minor percentage exhibit cultural modification, with the majority of modifications visible on valve fragments. A dozen shell hoes from Hahn are also identified to species where possible. Existing data suggest that mussel soft tissue is low in caloric content and nutritional value. Nevertheless, the low return in nutrition may have been offset by easy access to large numbers of individuals.

Introduction

Freshwater bivalves, often referred to as "mussels," are commonly recovered at Late Prehistoric sites in the Cincinnati vicinity (Metz 1881:299-300; Oehler 1973:38-41; Cowan 1987:23; Warren 1994; Vickery et al. 2000:290-291). Their valves were crushed and used as temper in fired-clay ceramics; they were modified for use as tools and ornaments; and their deposition in large numbers, where shells are unmodified and the valves are still attached, indicate that prehistoric people used them as a food source.

This article is a preliminary examination of Late Prehistoric freshwater bivalve procurement at the Hahn site, a multicomponent Late Woodland and Late Prehistoric village site near Cincinnati, Ohio. The sample examined here includes robust assemblages of freshwater bivalves from two trash-filled storage pits. The freshwater bivalves in each of these pit features are interpreted as probable single episode, primary depositions of food waste. The primary goals of this paper are: (1) identify sample bivalves to species, where possible, (2) examine the range and diversity of discarded bivalves, (3) make interpretations on the nature of the discarded bivalves as a food source, and (4) compare prehistoric bivalve diversity, as represented by the Hahn sample, to contemporary Little Miami River bivalve diversity.

Hahn Site

Hahn (33Ha10) is located within the lower reaches of the Little Miami River Valley, approximately six kilometers east-northeast of the Little Miami River-Ohio River confluence (Figure 1). The site occupies an isolated and elevated glacial outwash terrace that places it above most seasonal and periodic flooding episodes. The Little Miami River Valley is approximately 1.9 kilometers in width in the vicinity

Robert A. Genheimer, George Rieveschl Curator of Archaeology, Cincinnati Museum Center, BGenheimer@cincymuseum.org
Stanley E. Hedeen, Emeritus Professor of Biology, Xavier University; Adjunct Curator, Cincinnati Museum Center

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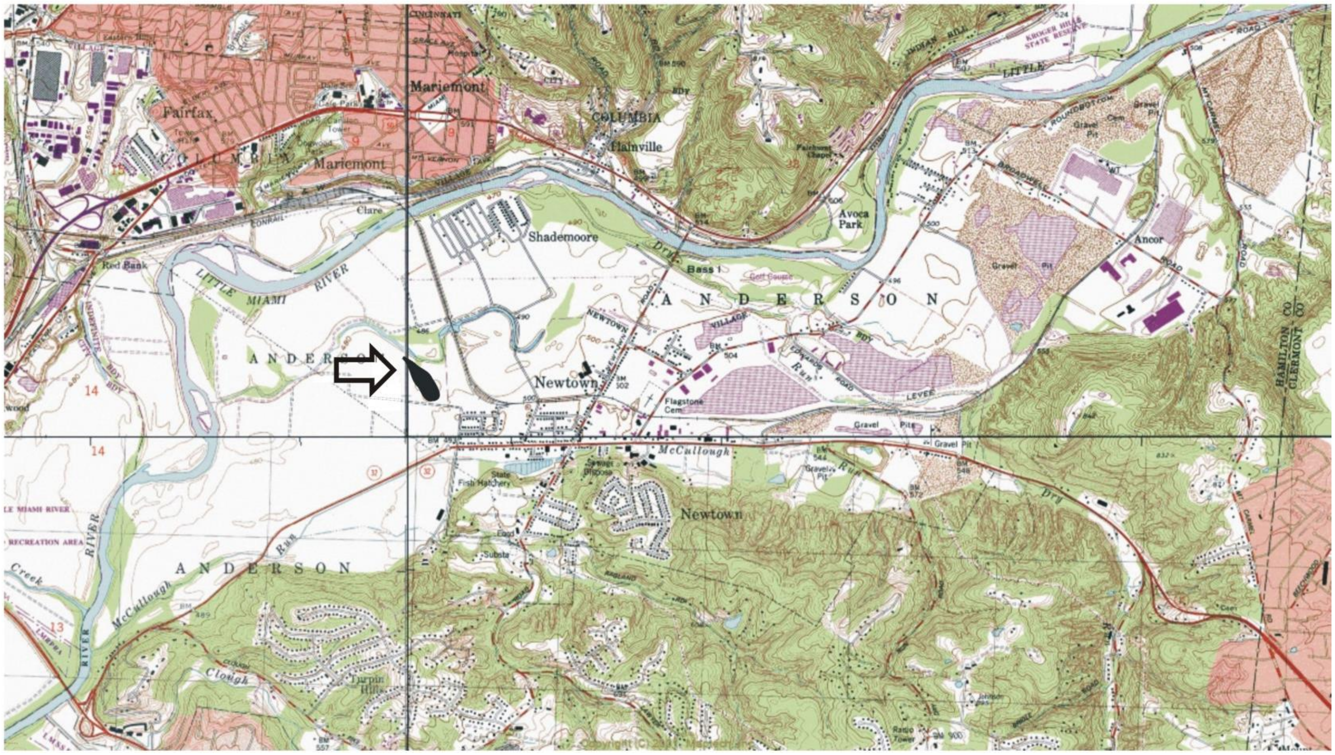

Figure 1. Location of the Hahn site within the lower portion of the Little Miami River Valley. Composite of Madeira, Withamsville, Newport, and Cincinnati East 7.5' USGS quadrangles.

of Hahn, but reaches widths of nearly 3.0 kilometers farther west and south. The Hahn site and areas to the southwest exhibit Huntington series soils that formed in alluvium derived from eroded shales and limestones. These well-drained soils are typically deep. The terrace that Hahn occupies is designated as Huntington silt loam, an often flooded soil that generally occurs on the highest elevations of the floodplain (Lerch et al. 1982:37, 104), but the Hahn terrace is elevated more than most areas of Huntington silt loam. Hahn sits above areas to the south and west by as much as 1.5 to 3.0 meters (5 to 10 feet). And, unlike the soil profiles issued for the Huntington series, the Hahn landform exhibits sand and gravel at depths between 1.0 and 1.5 meters below surface. At several tested areas of Hahn, this underlying sand and compact gravel acted as a barrier to deeper excavations by prehistoric inhabitants, effectively limiting the depths of storage and trash pits.

Hahn is located in close proximity to several other prominent prehistoric sites in the lower Little Miami River Valley. The Madisonville site, 33HA14 and 33HA122(36), to which Hahn illustrates a close affinity, is located only 1.5 km to the north-northwest on the opposite side of the river. Hahn is 1.0 km west-southwest of the Newtown Firehouse site, 33HA419, 2.4 km northeast of the Turpin site, 33HA105(19), and 5.7 km west-southwest of the former location of Turner Earthworks, 33HA26.

Archaeological Investigations

The Hahn site was identified in the early 1880s by Dr. Charles Metz, a Cincinnati-area physician. The site was known for producing copious quantities of flint, ceramics, animal bone, and mussel shell (Metz 1881:299-300). Human skeletons were also exposed during these early investigations, and in 1885 Metz, under the absentee direction of Frederick Ward Putnam of Peabody Museum at Harvard, briefly excavated a peripheral portion of the site. Peabody did not return to the site, but due to its abundant surface remains, the Hahn site became a favored surface-collecting locality throughout the remainder of the nineteenth century and during much of the twentieth century. There were apparently brief post WWII attempts at testing the site by the Cincinnati Museum of Natural History and the Glenn A. Black Laboratory of

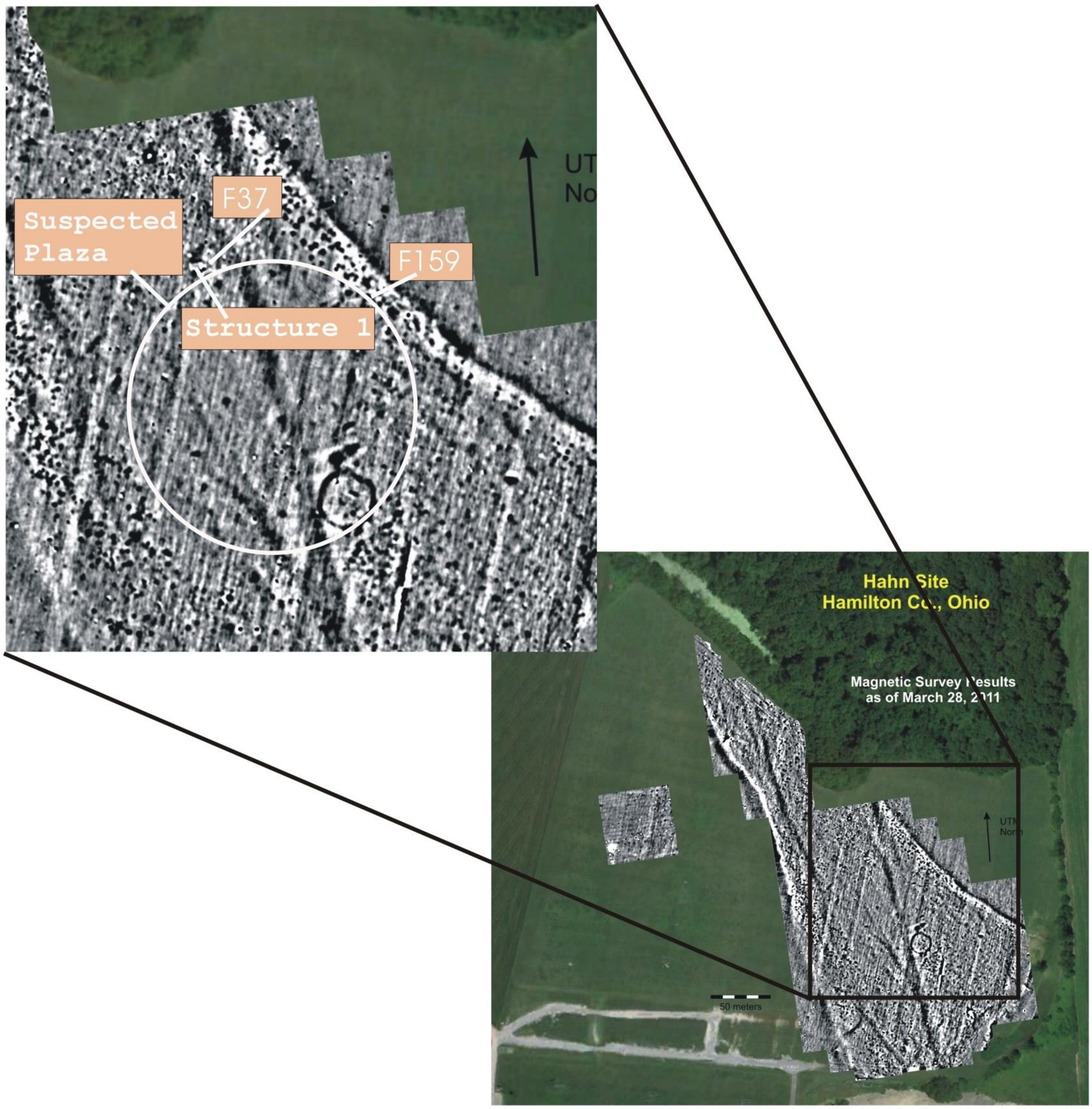

Figure 2. Magnetometry map showing features discussed in this paper. Magnetometry image courtesy of Jarrod Burks.

Archaeology at Indiana University, but no field notes have been located to place these excavations into a spatial context. After WWII, and extending into the early 1990s, the site was subjected to isolated looting primarily at its northern end, in the vicinity of the Peabody blocks.

In an effort to place Hahn into a developing chronological sequence of central Ohio River Valley Fort Ancient sites, and to answer questions of site/cultural relationships between Hahn and numerous other Fort Ancient sites in the vicinity, the Cincinnati Museum Center launched a testing program at the site in the summer of 2008. Since 2008, six archaeological field schools, each of four-week duration, have been conducted at the site. Between June of 2009 and June of 2011, a robust remote sensing program was undertaken at the site. Magnetometry (i.e., gradiometry) served as the main technique in this program, although magnetic susceptibility and ground-penetrating radar were also employed. All remote sensing was undertaken by Jarrod Burks of Ohio Valley Archaeology, Inc.

The gradiometry data suggest that the site encompasses at least 35,000 square meters, or more than 8.6 acres. The distribution of magnetic anomalies indicate the site is at least 250 meters in length (north-northwest to south-southeast) and a maximum of 175 meters in width (east-west). The magnetic data also suggest that hundreds of probable pit features and/or burials are represented across the site. A near absence of magnetic anomalies near the center of the site most likely represents a central plaza that may have been maintained through the middle and late Fort Ancient periods.

Remote sensing data have guided much of the archaeological excavation at the site. Between 2008 and 2010, archaeological excavations were focused on the exposure of a complete middle Fort Ancient wall trench structure (Structure 1) on the northern perimeter of the proposed central plaza. Feature 37, one of the pit features utilized in the Hahn bivalve sample, intruded into and removed the northeast corner of this structure. Additional excavations have focused on ground-truthing magnetic anomalies, particularly those suspected of being trash-filled storage pits. In 2013, a stockade segment was discovered along the eastern edge of the site. It was during this investigation that Feature 159, the second of the pit features utilized in the Hahn bivalve sample, was excavated (Figure 2). Through the 2013 field season, a total of 147 features have been excavated, including 93 post holes, 30 trash-filled storage pits, 8 looter pits/trenches, 7 earth ovens, 4 wall trenches, 2 filled depressions, a collapsed wall, a dog burial, and a thermal feature of unidentified function.

After six years of excavations, the following observations can be made. First, the major occupations at Hahn, given the degree of documented prehistoric subgrade intrusions, date to the middle Fort Ancient (ca. AD 1200-1400) and late Fort Ancient (Madisonville) (ca. AD 1400-1650). It is suspected that the earlier Fort Ancient occupation took the form of a circular or semi-circular village with a near-vacant central plaza; however, beyond the magnetic data there is insufficient settlement data to confirm or deny this assumption. The putative plaza location appears to be devoid of Late Prehistoric intrusions, suggesting that this common space was also respected during the later Madisonville occupation. Second, nearly all pit features (trash-filled storage pits and earth ovens), occurring over a wide area of the site, have produced Madisonville diagnostics indicating that this terminal occupation was intensive and widespread. Third, a considerable Late Woodland occupation is suggested by significant frequencies of limestone and grit-tempered ceramics within site boundaries, and the excavation of at least two suspected, but as yet undated, Late Woodland earth ovens. And, fourth, at least a minor Middle Woodland occupation can be inferred by the presence of a quasi-circular earthwork located near the south edge of the suspected plaza. However, little or no artifactual material can be assigned to this time period.

Bivalves at Hahn

Freshwater bivalves at Hahn occur as complete valves, fragmented valves, and, infrequently, as paired valves from a single individual (i.e., complete bivalves discarded with their hinge ligament still intact). Due to the friable nature of freshwater shells and their breakage through prehistoric processing and discard, the vast majority recovered from Hahn were fragmented valves. Bivalve fragments occur nearly everywhere at Hahn and constitute a significant percentage of recovered debris by both count and weight. Of 490,652 fragments of debris weighing more than 1280 kg that has been catalogued through the end of

Table 1. Radiocarbon dates for Feature 37.

Context	Lab #	Material	Conventional Radiocarbon Age	2 sigma calibration
Feature 37, 71-81 cm below datum	AA98051	maize kernel	612+/- 38 BP	Cal AD 1292-1406
Feature 37, 31-41 cm below datum	Beta-370996	maize kernel	240+/- 30 BP	Cal AD 1640-1670
Feature 37, Horizon C	Beta-370995	wood charcoal	150+/- 30 BP	Cal AD 1670-1780

2013, non-worked freshwater bivalve fragments account for 10.5% of total site debris by count (n=51,731), and 11.7% by weight (150.1 kg).

Bivalve Samples

While fragmented bivalves dominate the Hahn assemblage, large numbers of complete or nearly complete bivalves were recovered from two trash-filled pits: Feature 37 and Feature 159. Both of the bivalve assemblages are primary deposits (i.e., fill that originated from those who excavated the pits), rather than general fill episodes (i.e., fill that originated from earlier occupations) common to many Hahn pit features. And, given the near absence of non-shell debris within the deposits, both pits almost certainly represent separate, single episode discard events. In each instance, a large percentage of paired valves were recovered from these pits. The freshwater bivalves from the discrete deposits within these two features constitute the bivalve sample examined for this paper. Although the two pit features are only 45 meters apart, and both are located just outside of the proposed site plaza within a suspected house ring, there are no data to suggest that they are related. Instead, they likely represent food waste from separate households.

Methodology

An attempt was made to identify all Hahn sample bivalves to species level utilizing the comparative malacology collections at the Cincinnati Museum Center. These synoptic collections include identified specimens from the midwestern and southeastern United States, and include large numbers of specimens recovered during the nineteenth century. Only whole and broken valves containing umbo and cardinal teeth were counted as identifiable specimens. A minimum number of individuals (MNI) was determined for each species by totaling the right or left valves, whichever were more numerous. It is assumed, but not demonstrated, that all sample bivalves were procured from the closest stream – the nearby Little Miami River—located approximately 800 meters to the north, and not the Ohio River, situated approximately 6.0 kilometers to the south-southwest. Before discussing the results of this analysis, a description of these feature contexts is in order.

Feature 37

This trash-filled storage pit excavated in 2009 intruded upon and removed the northeast corner of Structure 1, and, hence, post-dates the middle Fort Ancient house (Figure 2). Feature 37 exhibited an average diameter of 1.37 meters, was bowl-shaped with a flat bottom in profile, and extended from approximately 21 cm to 94 cm below present ground surface. Its volume was approximately 0.88 cubic meters. Although not the largest trash-filled storage pit encountered at Hahn, its recovered debris totals, both by count and weight, were the highest recorded for any feature at the site: a total of 30,675 fragments of debris, weighing 104.54 kg.

Feature 37 produced numerous temporally diagnostic middle and late Fort Ancient period artifacts. The presence of a bi-pointed knife and three flint bifacial endscrapers indicates that the feature originated during the Madisonville Phase, while incised and punctated ceramic sherds, diagnostic for middle Fort Ancient, suggest that pre-Madisonville debris was utilized to fill the pit at some intervals. A conventional radiocarbon age of 612 +/- 38 BP (AA98051) from a maize kernel in Level 7 (71-81 cm) of the south half confirms the inclusion of pre-Madisonville debris (Table 1). Two more dates, one on a maize kernel from Level 3 (31-41 cm), south half, and the other on wood charcoal from Horizon C directly below the bivalve deposit, returned conventional radiocarbon ages of 240 +/- 30 BP (Beta-370996) and 150 +/- 30 BP (Beta-370995), respectively (Table1). These results suggest that the sample mussels were deposited during the site's final occupation.

Large numbers of freshwater bivalves were noted in the top four 10 cm levels and subsequent exposure of the feature profile (Figure 3) revealed a relatively thick, concave-shaped deposit of bivalves extending across the feature face, and just below a cap of dark midden. The width of this lens, designated Horizon B, varied from approximately 6 cm along the western edge of the feature to as much as 16 cm in the center of the pit.

In order to be certain that bivalve and bivalve fragments were exclusively from Horizon B, only shells from the northern half of the feature were analyzed. In that half alone, a total of 5,441 bivalve fragments, weighing 27.43 kg were recovered. Of that total, 2,978 bivalves were identifiable to the species level, for an MNI of 1,539.

Feature 159

This trash-filled storage pit excavated in 2012 was recorded near the western end of a ten-meter-long trench placed to intercept a potential stockade

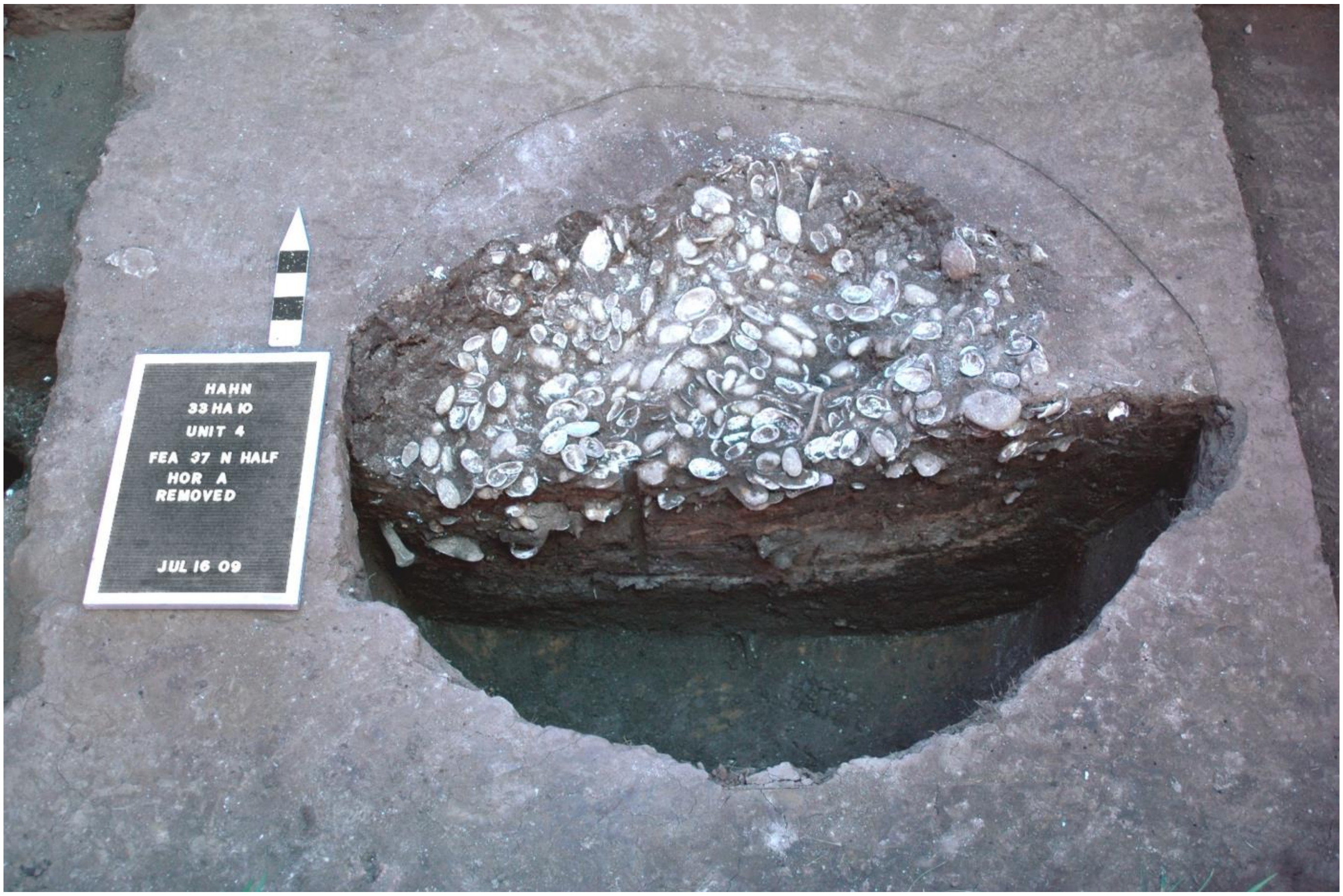

Figure 3. Feature 37 with south half and Horizon A of north half removed exposing dense bivalve deposition (Horizon B).

line or lines at the eastern end of the site (Figure 2). Feature 159 exhibited an average diameter of 1.08 meters, was basin shaped with incurving walls and a rounded bottom, and extended from approximately 28 cm to 103 cm below present ground surface. Its volume was determined to be approximately 0.54 cubic meters. Approximately 10,600 fragments of cultural debris, weighing more than 37.19 kg were recovered.

No absolute dates are available for Feature 159, and relatively few temporally diagnostic artifacts were identified. Five artifacts, including four incised ceramic sherds and one squat strap handle, are clearly indicative of the middle Fort Ancient period. However, the recovery of a large, broad, and thin strap handle from 42-52 cm below surface suggests a late (Madisonville) Fort Ancient origin for this pit.

Large quantities of freshwater bivalves, many with both valves intact, were noted in the south half in Levels 1 (42-52 cm) and 2 (52-62 cm) of Feature 159 (Figure 4). The analyzed sample from Feature 159 came from Levels 1 and 2 in the south half and Horizon A in the north half. It consisted of a total of 4,141 bivalve and/or bivalve fragments weighing more than 2.32 kg. Of that total, 2,161 bivalves were identified to the species level, for an MNI of 1,118.

Analysis

The examination of 9,582 freshwater bivalves and bivalve fragments from Features 37 and 159 identified 5,139 bivalves to species level (MNI of 2657). A total of 24 species were identified from Feature 37, and 22 species were identified from Feature 159 (Table 2). Twenty-six species were identified for the combined features, with 20 common species represented in both pits.

There is a remarkable similarity between the two feature assemblages that goes beyond the 20 common species. In general, species represented by relatively few individuals in one feature are typically poorly represented in the other, as well. Likewise, species that are represented by a greater number of individuals in one pit typically are well represented in the

Figure 4. Feature 159 with south half removed. Note dense bivalve deposition in north half of Horizon A.

other pit, too. This suggests that the same or similar procurement location was exploited. The Kidneyshell (*Ptychobranchus fasciolaris*), a medium- to large-sized species, is the most common mussel within each feature, representing between a quarter and nearly a third of all specimens collected by the prehistoric occupants of the site. Several additional species also are well represented, including the medium-sized species Spike (*Elliptio dilatata*) and Fatmucket (*Lampsilis siliquoidea*), and the small Clubshell (*Pleurobema clava*). The remaining 22 mussel species are each represented by less than 5% of the combined feature totals (Table 2).

With the caveat that individual species within the bivalve sample vary greatly with regard to size, an attempt was made to grade identified species by general size utilizing maximum length data available on the Animal Diversity Web (ADW) (University of Michigan, Museum of Zoology 2014). The 26 identified species range in maximum length from 3.8 cm (*Alasmidonta virdis*) to 25.0 cm (*Ligumia recta*) (Table 3). For the purposes of this paper, mussels were segregated into medium-to-large size (15.0 cm or larger maximum length), medium size (10.0 to 14.9 cm maximum length), and small size (less than 10.0 cm in maximum length). A graphical representation of MNI for species' maximum length (Figure 5) illustrates that, although the prehistoric occupants at Hahn selected a wide range of species, they collected relatively few very large, and relatively few very small, species. Instead, procurement focused on five species of medium-to-large (*Amblema plicata* and *Ptychobranchus fasciolaris*), medium (*Elliptio dilatata* and *Lampsilis siliquoidea*), and small (*Pleurobema clava*) bivalves. These five species account for 77.8% of all identified bivalves in the combined feature sample. It is not known whether this selection was intentional, or if it represents bivalve availability at the point of exploitation.

Typical substrate and flow data, when available, were also extracted from the ADW for all sample bivalves. Typical substrates include mud, silt, sand,

Table 2. Frequency, MNI, and percent of identified freshwater bivalves for sample deposits in Features 37 and 159 at the Hahn site.

		Feature 37			Feature 159		
Species	**Common Name**	**Freq.**	**MNI**	**%[1]**	**Freq.**	**MNI**	**%[1]**
Actinonaias ligamentina	Mucket	64	38	2.5	51	27	2.4
Alasmidonta marginata	Elktoe	62	32	2.1	15	8	0.7
Alasmidonta viridis	Slippershell	24	14	0.9	--	--	--
Amblema plicata	Threeridge	124	65	4.2	114	58	5.2
Cyclonaias tuberculata	Purple Wartyback	37	20	1.3	37	18	1.6
Elliptio crassidens	Elephant-Ear	3	2	0.1	--	--	--
Elliptio dilatata	Spike	627	314	20.4	348	176	15.7
Epioblasma torulosa	Northern Riffleshell	--	--	--	25	14	1.3
Epioblasma triquetra	Snuffbox	17	9	0.6	--	--	--
Fusconaia flava	Wabash Pigtoe	77	40	2.6	37	18	1.6
Lampsilis cardium	Plain Pocketbook	59	32	2.1	27	14	1.3
Lampsilis ovata	Pocketbook	18	10	0.6	2	1	<0.1
Lampsilis siliquoidea	Fatmucket	310	158	10.3	339	177	15.8
Lasmigona costata	Fluted-Shell	115	59	3.8	45	23	2.1
Ligumia recta	Black Sandshell	32	18	1.2	29	14	1.3
Obovaria subrotunda	Round Hickorynut	90	46	3.0	4	2	0.2
Pleurobema clava	Clubshell	408	207	13.4	309	170	15.2
Pleurobema cordatum	Ohio Pigtoe	4	2	0.1	5	4	0.4
Pleurobema sintoxia	Round Pigtoe	6	4	0.3	2	1	0.1
Potamilus alatus	Pink Heelsplitter	25	13	0.8	41	22	2.0
Potamilus ohiensis	Pink Papershell	18	9	0.6	--	--	--
Ptychobranchus fasciolaris	Kidneyshell	777	402	26.1	671	340	30.4
Strophitus undulatus	Creeper	58	33	2.1	37	18	1.6
Tritogonia verrucosa	Pistolgrip	3	2	0.1	6	3	0.3
Truncilla donaciformis	Fawnsfoot	--	--	--	6	3	0.3
Truncilla truncata	Deertoe	20	10	0.6	11	7	0.6
TOTAL		2978	1539	99.8	2161	1118	100.2

[1] percent of MNI.

gravel, and rock, or combinations of one or more (Table 3). Given that the Little Miami River cuts through Ordovician-age bedrock, and the stream acted as a glacio-fluvial outwash channel during periods of glaciation, all of these conditions are present in the river channel near the Hahn site (Lerch et al. 1982:2). Only general data are available for preferred flow conditions. A wide diversity of flow, ranging from quiet to low to moderate to swift, is represented. For three species, a preference for riffles is also noted. Since the deposits in Features 37 and 159 almost certainly represent single procurement episodes, this range of flow types may suggest that collection took place along an undefined stretch of the Little Miami River that exhibited all of these various habitat niches.

Contemporary Mussel Sampling

In an attempt to compare and contrast this study's prehistoric bivalve diversity with present bivalve diversity near Hahn, contemporary bivalve assessments of the Little Miami River were examined. Recent sampling of Little Miami River mussel populations in the vicinity of the Hahn site indicates that there is less diversity of mussel species today than what is documented for the bivalves in these features during the middle/late Fort Ancient periods. Hoggarth and Goodman (2007) conducted a catchment basin survey that included the mainstream of the Little Miami River, the East Fork, Todd's Fork, and Caesar Creek. Sample data are provided for 1990-1991 and 2006-2007 assessments. Five of their sampling locations

Table 3. Identified sample mussels for combined features arranged in descending order of size and with general substrate/flow data.

Species	MNI	%	ML	Substrate/Flow
Medium-to-Large Size				
Ligumia recta	32	1.2	25.0	sandy mud, firm sand or gravel/ good flow
Potamilus alatus	35	1.3	20.3	various substrates/ slower flow
Tritogonia verrucosa	5	0.2	20.0	mud, silt, sand, or gravel/no flow data
Amblema plicata	123	4.6	17.8	mud, sand, and gravel/ no flow data
Lampsilis cardium	46	1.7	17.8	mud, sand, and gravel/ no flow data
Lasmigona costata	82	3.1	17.8	sand, mud, or fine gravel/ slow to moderate flow
Potamilus ohiensis	9	0.3	17.8	silt, mud, or sand/ fairly swift flows
Lampsilis ovata	11	0.4	15.2	coarse sand or gravel/ no flow data
Ptychobranchus fasciolaris	742	27.9	15.2	sand and/or gravel/ fairly good flow
Actinonaias ligamentina	65	2.4	15.0	coarse sand and gravel/no flow data
Elliptio crassidens	2	<0.1	15.0	mud, sand, gravel, and rock/ moderate to swift flow
Medium Size				
Cyclonaias tuberculata	38	1.4	12.7	no substrate data/ clear water
Elliptio dilatata	490	18.4	12.7	sand-gravel or mud-gravel/ no flow data
Lampsilis siliquoidea	335	12.6	12.7	sandy-mud substrates/ quiet water
Pleurobema cordatum	6	0.2	10.2	sand or gravel/ moderate flow
Pleurobema sintoxia	5	0.2	10.2	mud, sand, and gravel/ moderate flow
Strophitus undulatus	51	1.9	10.2	sand, sand/mud, and mud/ swift to standing water[1]
Alasmidonta marginata	40	1.5	10.0	mixed sand and gravel/ no flow data
Small Size				
Epioblasma torulosa	14	1.3	7.6	fine to coarse gravel/ riffles and runs
Fusconaia flava	58	2.2	7.6	mud, sand, and gravel/ moderate flow
Obovaria subrotunda	48	1.8	7.6	sand and gravel/ slow to swift flow
Pleurobema clava	377	14.2	7.6	coarse sand and gravel/ well oxygenated riffles
Epioblasma triquetra	9	0.3	6.4	sand and gravel/ swift current, usually riffles[2]
Truncilla donaciformis	3	0.1	5.1	sand or sandy mud/ slower flow
Truncilla truncata	17	0.6	5.1	mud, sand, or gravel/ no flow data
Alasmidonta viridis	14	0.5	3.8	buried in sand or gravel/ no flow data
TOTAL	2657	100.4		

[1] Warren 1991; [2] Parmalee 1967.

ML=maximum length of species. Maximum length and substrate/flow data from Animal Diversity Web (//animaldiversity.ummz.umich.edu) (University of Michigan Museum of Zoology 2014) except where noted.

(42.5, 43, 44, 45 upstream, and 45 downstream) are utilized in this paper to evaluate contemporary populations: locations 42.5, 43, and 44 are approximately 1.9 kilometers northeast of Hahn at or just upstream from the Newtown Bridge. Sample locations 45 upstream and 45 downstream are situated approximately 3.2 kilometers southwest of Hahn on either side (upstream and downstream) of the State Route 125/State Route 32 bridge.

Only fourteen species (live and dead) are presently confirmed for the lower portion of the Little Miami River (Table 3), and are represented by only 145 individuals. Ten of these species are also present in the Hahn site mussel sample. Of these ten species, six are medium-to-large-sized, two are medium-sized, and two are small-sized bivalves.

After his initial surveys of 1990/1991, Hoggarth (1992) warned that the mussel fauna in the Little Miami River watershed was at a crossroads, with one-third of extant species in danger of being lost and another third represented by non-viable populations. By 2007, mussel populations had declined further, although the lower reaches of the mainstream were found to have much more diverse mussel fauna than the middle and upper segments, due in part to the introduction of mussel species that utilize the freshwater drum as host (Hoggarth and Goodman 2007:3).

It is interesting to note that only two of the species identified in the five Hogarth and Goodman (2007) sample locations (*Alasmidonta marginata* and *Tritogonia verrucosa*) are listed as sensitive to turbid-

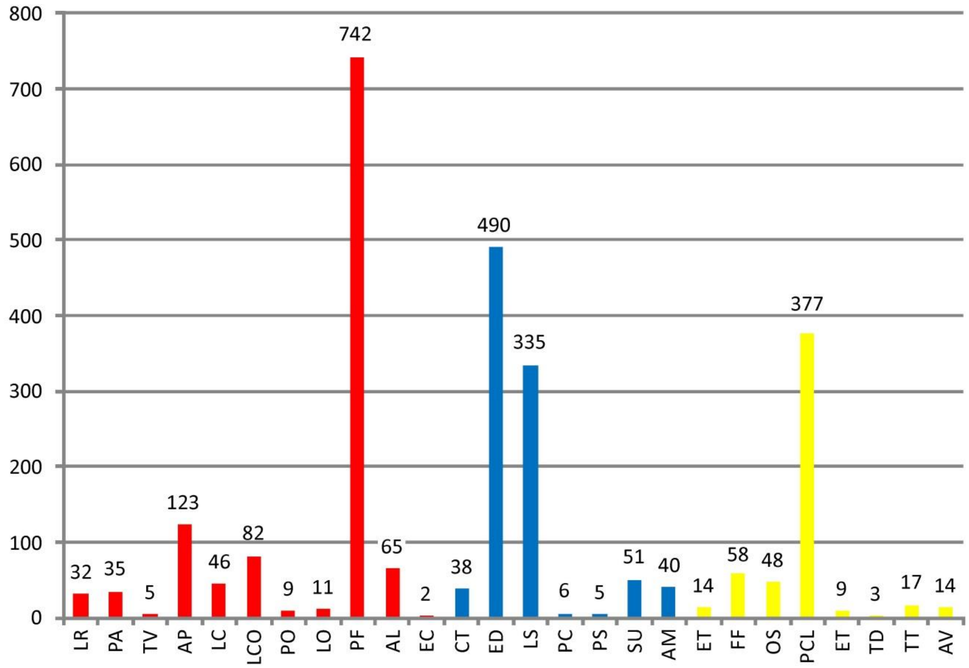

Figure 5. MNI of combined feature bivalves by size. Species decrease in size from left (25.0 cm maximum length) to right (3.8 cm minimum length). Red (medium-to-large size); Blue (medium size); Yellow (small size); LR *Ligumia recta*, PA *Potamilus alatus*, TV *Tritigonia verrucosa*, AP *Amblema plicata*, LC *Lampsilis cardium*, LCO *Lasmigona costata*, PO *Potamilus ohiensis*, LO *Lampsilis ovata*, PF *Ptychobranchus fasciolaris*, AL *Actinonaias ligamentina*, EC *Elliptio crassidens*, CT *Cyclonaias tuberculata*, ED *Elliptio dilatata*, LS *Lampsilis siliquoidea*, PC *Pleurobema cordatum*, PS *Pleurobema sintoxia*, SU *Strophitus undulatus*, AM *Alasmidonta marginata*, ET *Epioblasma torulosa*, FF *Fusconaia flava*, OS *Obovaria subrotunda*, PCL *Pleurobema clava*, ET *Epioblasma triquetra*, TD *Truncilla donaciformis*, TT *Truncilla truncata*, AV *Alasmidonta virdis*.

ity and sedimentation by Grabarkiewicz and Davis (2008). And, they account for only three individuals. In contrast, those two species, plus nine additional species from the Hahn sample (*Alasmidonta virdis*, *Cyclonaias tuberculota*, *Elliptio dilatata*, *Epioblasma torulosa*, *Epioblasma triquetra*, *Pleurobema clava*, *Pleurobema cordatum*, *Pleurobema sintoxia*, and *Ptychobrranchus fasciolaris*) are sensitive to turbidity and sedimentation. This suggests that historic increases in siltation and turbidity have caused a severe decline or extirpation of many mussels. The extent of this decline/extirpation is evident when the Hahn sample species list is examined. The eleven species sensitive to turbidity and sedimentation in the Hahn sample account for 65.5% of the total sample and include the top three identified species in the sample – *Ptychobranchus fasciolaris*, *Elliptio dilatata*, and *Pleurobema clava* (Table 1).

As a result of historic decline or extirpation, a number of species in the Hahn sample are currently listed on the Ohio Endangered Species list (Watters et al. 2009). These include the Elephant-Ear (*Elliptio crassidens*), the Northern Riffleshell (*Epioblasma torulosa*), the Snuffbox (*Epioblasma triquetra*), the Pocketbook (*Lampsilis ovata*), the Clubshell (*Pleurobema clava*), and the Ohio Pigtoe (*Pleurobema cordatum*). With the exception of the Clubshell, they all occur in relatively small numbers in the Hahn sample. Three species on the Ohio Endangered Species list (*Epioblasma torulosa*, *Epioblasma triquetra*, and *Pleurobema clava*) are also listed as Federally Endangered (Watters et al. 2009; U. S. Fish and Wildlife Service 2012).

Comparison to Other Fort Ancient Site Mussel Assemblages

The Hahn mussel sample was compared to freshwater bivalve assemblages analyzed from three other Late Prehistoric sites in the Cincinnati area. These sites include the nearby Madisonville site on the Little Miami River, the State Line site on the Great Miami

River, and the Petersburg site on the Ohio River downstream from Cincinnati.

Archaeologically recovered mussels were identified at the nearby Madisonville site, 33HA122(36), the type site of the Madisonville Phase (Warren 1994). These mussels were collected from a variety of contexts (17 pit features and a 1m by 2m trench cut into a midden-filled ravine) and are a smaller sample than Hahn's. Thirty-four species were identified from 808 individuals (MNI) (Warren 1994). Twenty four of the identified Madisonville species are present in the Hahn sample. Like Hahn, the Kidneyshell (*Ptychobranchus fasciolaris*) is the most common species at Madisonville, but while the Hahn sample is dominated by four species that account for nearly three-quarters of the assemblage (*Ptychobranchus fasciolaris*, *Elliptio dilatata*, *Pleurobema clava*, and *Lampsilis siliquoidea*), at Madisonville no species other than the Kidneyshell occur in quantities of greater than 10% of the total.

A similar range of mussel species was identified at the middle Fort Ancient State Line site, 33HA58, located along the lower reaches of the Great Miami River approximately 38.5 kilometers west of the Hahn Site (Vickery et al. 2000:290-291). At least 27 species were identified there, although the number of specimens (n=242) and MNI (n=135) were considerably less than the Hahn sample. The State Line specimens came from multiple contexts and do not represent a single episode harvest. Fourteen of the State Line species are present in the Hahn sample. These fourteen small- to medium-to-large-sized bivalves represent nearly 63% of MNI at the State Line assemblage.

At the Petersburg site, 16BE6, a large, multicomponent Late Prehistoric site near the confluence of Taylor Creek with the Ohio River in Boone County, Kentucky, all freshwater bivalves collected during early 1990s archaeological salvage operations were examined for species identification (Call 1993). Petersburg, which exhibits both middle Fort Ancient and Madisonville-age occupations, is located approximately 43.5 km west-southwest of the Hahn site. Twenty-eight species were identified from 946 specimens; however, MNI was not calculated due to the fragmented nature of the valves. The species composition at Petersburg is typical of large river shoals, and as a result, less than half (n=12) of the Petersburg species are present in the Hahn sample (Call 1993:87-88). The twelve species in common between Petersburg and Hahn are small- to medium-to-large-sized bivalves.

Mussel species can vary significantly even between proximally located drainages, and as a result, species comparison across drainages can be problematic. For example, Hahn and Madisonville share the greatest number of identified species, in part because they exhibit contemporary occupations and may have shared the same or nearby bivalve collecting locales. Fewer common species are noted between Hahn and State Line, with the latter site located in the lower reaches of a similarly-sized Ohio River tributary but at a considerable distance from Hahn. Even fewer common species are noted for Hahn and Petersburg, mostly due to the prevalence of large river species at the latter. Nevertheless, a large number of identified species at each of the three sites suggests that non-selective harvesting was common during the Late Prehistoric period.

Discussion

The freshwater bivalves from two trash-filled pit feature contexts at the Hahn site, Features 37 and 159, were almost certainly considered a food source by the prehistoric occupants. The mussels were likely baked or steamed to cook their flesh and to facilitate the opening of the valves. There is no thermal evidence to suggest that they were steamed or cooked in these pit features, so it seems likely that they were processed elsewhere before the shells were discarded in Features 37 and 159.

Identification of the two mussel deposits as food waste is strongly indicated by an examination of modified valves, items that had been transformed into tools or ornaments, or items from which fragments had been removed. None of the bivalve or bivalve fragments from Feature 37's main deposit (Horizon B) had been modified, and only four modified valves were encountered within the remainder of the feature. Only one modified bivalve was encountered in Feature 159, and this drilled bead was recovered well below the main deposit. This near absence of modification indicates that the bivalves were collected, processed, and discarded as part of food-preparation events, and not to prepare the shells further for use as functional or ornamental items.

This overwhelming evidence of the selection of bivalves as food is also noted for the site as a whole. Only 34 modified bivalves or bivalve fragments, less than 0.1% of all recovered freshwater bivalves, have been identified at Hahn through 2013. These include notched (n=6), drilled (n=3), scalloped (n=2), fringed (n=2), cut (n=1), and otherwise modified (n=7) specimens, as well as thirteen drilled shell hoe and hoe fragments. Twelve of the shell hoes were identifiable to species, and they illustrate a clear preference for a smaller range of species (n=3) than those identified for the food remains. Nine were manufactured from the Threeridge (*Amblema plicata*), a medium-to-large mussel with a strengthening set of ridges extending in a linear fashion from the umbo/hinge (Table 4).

Parmalee and Klippel (1974:432) determined through live sampling of mussels from the Midwest that mussels contain relatively minor quantities of soft tissue and are not particularly high in food energy. They likely served as a food supplement rather than a staple. For example, for the 11 species in Parmalee and Klippel's sample that are also present within the Hahn sample, average soft tissue weights range between 7 (*Truncilla truncata*) and 76 (*Ligumia recta*) grams (Parmalee and Klippel 1974:424). Based on these averages, the total soft tissue weight for these 11 species (comprising 41.6% of the MNI in the Hahn sample) would be approximately 33 kg, similar to the meat yield of perhaps two adult White-Tailed Deer (Madrigal and Holt 2002:748), although the caloric content and nutritional value are hardly equal. However, others (Claassen 1986; Erlandson 1988) have suggested that shellfish collection may have been important seasonally (Claassen 1986), or that mussels may have provided an important source of protein for peoples dependent on plant carbohydrates (Erlandson 1988). Utilizing projected harvest rates at the Azlatan site in Wisconsin, Theler (1991:328) suggests that freshwater mussels may have represented a "potentially important seasonal dietary supplement," provided that the mussels were not overtaxed.

Given the quantities of meat-rich mammal, fish, and bird remains recovered from Hahn, and the relatively low nutritional value of mussels, why did the site inhabitants harvest mussels for food? It is possible that their occurrence in dense beds in shallow water made them readily available with little effort. In other words, their low nutritional value could have been negated by the ease in collecting mass quantities. This appears to be the case for the dense deposits found in Features 37 and 159 at Hahn. The size of mussels, from small to medium-to-large, is not suggestive of selective procurement, but rather the harvest of all live specimens from one or multiple nearby locations.

But prehistoric Fort Ancient people used mussels in other important ways. For example, although most mussels may have been collected initially as a supplemental food resource, in some instances their crushed valves were utilized as a tempering agent in Fort Ancient pottery. Ceramic analyses at Hahn reveal that mussel shell was already being utilized for temper during the initial Late Prehistoric village occupation at the site (i.e., the middle Fort Ancient period). Shell was mixed with additives, such as crushed granitic rock or limestone, at least during the early portions of the middle Fort Ancient period. But by the Madisonville Phase, shell temper became the near exclusive temper (Riggs 1998; Cook and Fargher 2008). Although it is difficult to estimate the quantity of mussels required to provide temper at Hahn, the recovery of approximately 70,000 ceramic sherds through the first five years of excavation suggests that significant quantities would have been necessary to support continual ceramic production.

Although the mussels from the Hahn features likely do not include all available Late Prehistoric age Little Miami River mussel species, the robust nature of the samples, and their remarkable similarity in species makeup and frequencies do suggest that they are representative of the local mussel diversity during the terminal occupation of the site. These two snapshots of mussel diversity paint a picture of stream quality prior to its decline associated with historic agricultural runoff, siltation, turbidity, and pollution. Historically, mussel diversity has also been affected by changes in fish species, many of which act as specific hosts for mussel propagation (Hoggarth and Goodman 2007:3; University of Michigan Museum of Zoology 2014).

It is possible that the prehistoric site inhabitants may have adversely affected mussel populations through over-harvesting, particularly at readily accessible areas with shallow water. Theler (1991:324) estimates that, after intensive mussel collection, it would take ten years or longer for a local mussel population to reestablish and reach usable size. The introduction of maize agriculture, particularly after AD 1000, and the concomitant effects of soil erosion and stream siltation, may have also impacted water quality and mussel diversity during the Late Prehistoric period. An analysis of the genus *Epioblasma*, recovered from 27 sites in the southeastern United States dating from the Archaic through the Mississippian periods, revealed a decline from 5000 to 500 BP, with a sharp decrease in *Epioblasma* abundance during the last millennium when land clearing and result-

Table 4. Mussel species (dead or alive) recorded in Hoggarth and Goodman (2007) study of Little Miami River catchment basin with comparisons to Hahn site sample.

		H&G Study		Hahn Sample		H&G Presence/Absence	
Species	**Size**	**Ct**	**%**	**Ct**	**%**	**1990-1991**	**2006-2007**
Alasmidonta marginata	M	2	1.4	40	1.5	A	P
Amblema plicata	M-L	4	2.8	123	4.6	P	P
Lampsilis cardium	M-L	5	3.4	46	1.7	P	P
Lampsilis siliquoidea	M	1	0.7	335	12.6	A	P
Lasmigona complanata	M-L	34	23.4	--	--	P	P
Lasmigona costata	M-L	1	0.7	82	3.1	P	P
Leptodea fragilis	M-L	14	9.7	--	--	P	P
Potamilus alatus	M-L	52	35.9	35	1.3	P	P
Potamilus ohiensis	M-L	7	4.8	9	0.3	P	P
Pyganodon grandis	M-L	10	6.9	--	--	P	P
Quadrula quadrula	M	4	2.8	--	--	A	P
Tritigonia verrucosa	M-L	1	0.7	5	0.2	A	P
Truncilla donaciformis	S	2	1.4	3	0.1	A	P
Truncilla truncata	S	8	5.5	17	0.6	A	P
TOTAL		145	100.1	n/a	n/a		

M – medium size; L – large size; S – small size

Table 5. Drilled shell hoes recovered from excavation and surface context at the Hahn site.

Provenience	Completeness	Weight (g)	Species
F59, 40-90 cm	complete	180.0	*Amblema plicata*
F59, Hor C	complete	159.7	*Amblema plicata*
F121, E ½, Hor C	complete	105.1	*Amblema plicata*
F146, U34, 30-40 cm	mostly complete	72.5	*Tritigonia verrucosa*
F146, U34, 30-40 cm	fragment	7.7	unknown
F162, 37-47 cm	complete	86.1	*Cyclonaias tuberculota*
F164, 2012 sample	complete	176.9	*Amblema plicata*
F165, 90-100 cm	fragment	53.8	*Amblema plicata*
F168, 70-90 cm	complete	106.2	*Amblema plicata*
F173, 110-120 cm	complete	149.8	*Cyclonaias tuberculota*
F175, 110-120 cm	complete	153.7	*Amblema plicata*
Surface	mostly complete	151.1	*Amblema plicata*
Surface	fragment	46.6	*Amblema plicata*

ing siltation associated with maize production were at their height (Peacock et al. 2005:550). Indeed, only 23 individuals from this genus were identified in the Hahn sample.

Conclusions

Analyses of a pair of robust, but spatially unassociated freshwater bivalve primary deposits at the Hahn site provide baseline data on Late Prehistoric mussel collection in the lower reaches of the Little Miami River Valley. One of the features, Feature 37, has been radiocarbon dated to the Madisonville Phase, while the other feature, Feature 159, is suspected to be Madisonville in age due to the presence of a temporally diagnostic ceramic strap handle. More than 9,500 freshwater bivalves and bivalve fragments were recovered from the combined pit feature samples, of which 5,139 specimens were identified to species level with an MNI of 2,657.

A combined total of 26 bivalve species were identified in the two feature deposits. Considerable similarity was noted between the two bivalve samples, with 20 species common to both. Medium- and medium-to-large-sized species are most prevalent in frequency, comprising more than three-fourths of the combined sample. Inclusion of a significant frequency of small-sized species suggest that prehistoric mussel exploitation focused on collection of all available species, and was not necessarily selective for larger species with greater amounts of edible soft tissue. Available flow data for identified bivalve species suggest that a variety of collection locales with variable current speed may have been utilized.

Recent investigations of bivalve populations in the last three decades in the Little Miami River illustrate that there is considerably less diversity in mussel species today than in what is documented in this paper for the middle/late Fort Ancient periods. Only 14 species were recovered from collecting locales near the Hahn site, and only 10 of these species are present in the Hahn sample. Very few species sensitive to turbidity and sedimentation were recovered during the recent sampling by Hoggarth and Goodman (2007), whereas 11 species sensitive to turbidity and sedimentation were identified in the Hahn sample. The absence of these particular bivalves from contemporary sampling locations near the Hahn site suggests that historic increases in siltation and turbidity have caused a severe decline in mussel diversity in the lower reaches of the Little Miami River.

Analyses of archaeological bivalve assemblages from the nearby Madisonville site, the State Line site in the Great Miami River Valley, and the Petersburg site on the Ohio River reveal that Late Prehistoric period people collected a wide range of mussel species including small- to medium-to-large-sized specimens. At each of these three sites, and Hahn, more than two dozen bivalve species have been identified. For Madisonville, State Line, and Petersburg, given that the bivalve samples from these sites were collected from general site contexts, there is insufficient data to suggest whether inclusive bivalve collecting was a common practice at these sites during late prehistory. For Hahn, where each of the two trash-filled pit feature samples most likely represent single episodes of collecting and processing, an inclusive collecting methodology of harvesting all or most available species is strongly indicated by both the broad range of species and the similarity in species composition between the pit feature samples.

The extremely low frequency of mussel modification, both within the Hahn sample pit features and the site as a whole, strongly indicates that bivalves were harvested primarily as a food source. Each bivalve provides only a small quantity of edible soft tissue, and, even though this tissue has low nutritional value, mass collecting of mussels may have produced sufficient quantities of meat to supplement a diet focused on maize agriculture, hunting, fishing, and the collection of plants. The waste from processing bivalves for food, large amounts of shell, may have been further utilized as a source of ceramic temper, but this clearly did not occur with the shell in the Hahn sample features.

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