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Dart Point Chronologies of Southeast Texas

Leland W. Patterson

Introduction

Ensor (1990: Figure 1) and Patterson (1990: Table 2) have published separate proposed chronologies for projectile point types in Southeast Texas. This article discusses the bases and differences of these two proposed chronologies, in regard to dart points. Comments on arrow point chronologies are given in a separate article (Patterson 1991).

It should be realized that projectile point chronologies are continuously refined, as new data become available. It would be ideal to have sufficient radiocarbon dates to establish a definitive time range for each projectile point type (Patterson 1989a), but this is generally not possible. Instead, the time range for each projectile point type is usually estimated, with varying degrees of accuracy, by use of some radiocarbon dates, data from excavations, data from surface collections, and published chronologies for adjacent regions.

There are generic problems in establishing estimates for projectile point chronologies. These include: (1) chronologies from adjacent regions do not always apply, (2) some investigators attempt to force individual projectile points into artificially narrow time ranges, (3) data on chronological sequences from single stratified sites are seldom conclusive on total time ranges of point types in a region, and (4) many investigators fail to consider the entire body of available data for a region. Also, it is not unusual for individual investigators to disagree on the classification of projectile point types.

Comments are given here on problems with Ensor's (1990: Figure 1) dart point chronology, and Patterson's (1990: Table 2) dart point chronology is discussed in some detail. It is shown that there are too many problems with Ensor's chronology for it to be of general usefulness.

Comments on Ensor's chronology

There are several problems with Ensor's (1990: Figure 1) proposed chronology for projectile points in Southeast Texas. The placement of time periods is confusing because of the differences with other published chronologies for this region. Ensor does not have a Late Paleo-Indian period, but instead pushes the Early Archaic period farther back in time. This in turn results in an unusually long Middle Archaic period, not synchronized with any other published chronology. Angostura, Plainview, and Golondrina points are shown slightly earlier than 8000 B.C. These point types actually all occur in the Late Paleo-Indian period of 8000-6000 B.C. and perhaps even to 5000 B.C. Ensor's placement of the San Patrice point before the Early Side-Notched point is not correct. Early Side-Notched points start earlier than San Patrice in Southeast Texas (Patterson et al. 1987). Early Side-Notched points also occur with San Patrice points (Patterson et al. 1987; Webb et al. 1971).

An Early Expanded Haft Cluster, consisting of Yarbrough, Trinity, and Carrollton point types, is shown by Ensor (1990: Figure 1) at 5000 B.C. This is a reasonable starting date for Trinity and Carrollton points, but it should be noted that the Carrollton point is a straight stem type, not expanding stem. The Yarbrough point is placed too early, based on a reference to Turner and Hester (1985). This will be corrected in the next issue of the book by Turner and Hester (E. S. Turner, personal communication) to show a later placement of this point type. The Yarbrough point is commonly found in the Late Archaic and Early Ceramic periods in Southeast Texas (Patterson 1989b; Hall 1981). Ensor seems to have missed a decimal place in having a Palmillas Cluster at

2000 B.C., based on a reference by Shafer (1988). Shafer (1988: Figure 1) places the Palmillas point about 200 B.C.

Ensor does not give time ranges that allow any overlap for individual dart point types. There is a significant body of data for Southeast Texas that shows long time overlaps for many dart point types. This will be discussed in relation to Patterson's proposed chronology. For example, the Gary/Kent Cluster starts much too late in Ensor's (1990: Figure 1) chronology, even though the text of his article admits evidence for the Gary/Kent series in the Middle Archaic period.

Ensor appears to have used only a few selected site references to develop his chronology, while overlooking some key references that give important related data. The entire body of data for Southeast Texas must be considered if a meaningful chronology is to be developed. Key references can be cited, but conclusions should not be contrary to other existing data. In summary, Ensor's (1990: Figure 1) proposed chronology should not be given general use, because time ranges for Archaic subperiods cannot be directly compared with other published chronologies, and there are problems with the temporal placement of several dart point types. In addition, Ensor's chronology is fairly limited in the number of dart point types considered.

Discussion of Patterson's chronology

It would not be fair to give much criticism to Ensor's (1990: Figure 1) proposed projectile point chronology for Southeast Texas without also discussing the basis for my latest proposed chronology (Patterson 1990a: Table 2) for this same region. My proposed chronology is given here again in Table 1. Time periods used are as follows:

	range	
period	years B.P.	years B.C./A.D.
Early Paleo-Indian	12,000–10,000	10,000–8,000 B.C.
Late Paleo-Indian	10,000– 7,000	8,000–5,000 B.C.
Early Archaic	7,000– 5,000	5,000–3,000 B.C.
Middle Archaic	5,000– 3,500	3,000–1,500 B.C.
Late Archaic	3,500– 1,900	1,500 B.C.–A.D. 100
Early Ceramic	1,900– 1,400	A.D. 100– 600
Late Prehistoric	1,400– 500	A.D. 600–1,500

As noted in the Introduction, this article discusses only dart point chronology, with the temporal placement of arrow point types considered in a separate article (Patterson 1991)

The Early Paleo-Indian time period in Texas has previously been considered mainly in terms of fluted points, with a Clovis time range of 10,000-9000 B.C. and a Folsom time range of 9000-8000 B.C. It now appears that side-notched points occur during much or all of the Folsom time period in Southeast Texas. Early Side-Notched points have been found at a site in Bee County at an excavation level below Folsom (Sellards 1940) and at a site in Wharton County (Patterson et al. 1987) at the same excavation level as Folsom. Also, Story (1990:202) thinks that the side-notched San Patrice point type starts about 8300 B.C. It should be noted that Folsom is a rare point type in Southeast Texas, with only two specimens published so far. The Early Side-Notched point is the prime candidate for being the major point type being used in Southeast Texas at the same time as the Folsom point was being used in other Texas regions.

There are several projectile point types that represent the Late Paleo-Indian period in Southeast Texas. Point types that indicate influences from the Southern Plains include Angostura, Meserve, Scottsbluff, and Plainview. Early Notched (both side- and corner-notched), San Patrice, and Early

Table 1. Dart Point Chronology of Southeast Texas

point type	Early Paleo	Late Paleo	E. Arch	M. Arch	L. Arch	Early Ceram	Late Prehist
Clovis	X						
Folsom	X						
Early Notched	X	X					
San Patrice		X					
Plainview		X					
Scottsbluff		X					
Angostura		X					
Meserve		X					
Early Stemmed		X	X				
Bell			X				
Trinity			X				
Wells			X	X			
Carrollton			X	X			
Morrill			X	X			
Bulverde				X			
Lange				X			
Pedernales				X	X		
Williams				X	X		
Travis				X	X		
large Gary				X	X		
large Kent				X	X		
Ponchartrain					X		
small Gary					X	X	X
small Kent					X	X	X
Darl					X	X	
Yarbrough					X	X	
Ensor					X	X	
Ellis					X	X	
Fairland					X	X	
Palmillas					X	X	
Marcos					X	X	

Stemmed point types indicate influences from the Southeast Woodlands. Early Notched and San Patrice points are placed in this period on the basis of excavation results at site 41WH19 (Patterson et al. 1987) and at a site in Louisiana (Webb et al. 1971). The Early Stemmed point is placed in this time period on the basis of excavation results at site 41HR315 (Patterson 1980) and at site 41WH19 (Patterson et al. 1987). Southern Plains lanceolate point types are placed in the Late Paleo-Indian period on the basis of references from regions to the northwest of Southeast Texas (Turner and Hester 1985). Also, a Plainview point was found at the Late Paleo-Indian excavation level at site 41WH19 (Patterson et al. 1987) and an Angostura point was found at the Late Paleo-Indian level at site 41FB42 (HAS field notes).

Early stemmed points seem to evolve into Carrollton and Bulverde-like point types in the Early Archaic period. Dart points have ground stem edges in the Paleo-Indian and Early Archaic periods, with some continuation of this practice into the Middle Archaic period. Bulverde-like points are present in the Early Archaic period at site 41WH19 (Patterson et al. 1987) and Carrollton points are in this period at excavations on sites 41HR315 (Patterson 1980) and 41FB37 (Patterson and Hudgins 1987). There is a radiocarbon date of 6490 ±120 B.P. (4540 B.C.) for a Carrollton or Carrollton-like point at site 41FB37 (Patterson 1988), at the beginning of the Early Archaic period. A Wells point is also present at 41FB37 at a slightly higher excavation level in the Early Archaic. Based on excavations at sites 41AU37 (Hall 1981) and 41HR315 (Patterson 1980), the Wells point type continues into some portion of the Middle Archaic. Trinity points were found in the Early Archaic period at site 41HR315 excavations (Patterson 1980). Bell and Morrill point types are placed in the Early Archaic in this chronology based on references given in Turner and Hester (1985).

It should be realized that the Middle Archaic period covers somewhat different time ranges in Central and Southeast Texas, due to pottery starting later in Central Texas than in Southeast Texas. For example, the Pedernales point is classified entirely in the Middle Archaic period in Central Texas, but occurs in both the Middle and Late Archaic periods in Southeast Texas, because of the regional differences in time ranges assigned. The Pedernales point was in the Middle Archaic level at sites 41AU37 (Hall 1981) and 41FB34, with an early radiocarbon date of 5210 ±110B.P. (3260 B.C.) at 41FB34 (Patterson 1989c).

The temporal placements of Morrill and Williams point types in this chronology are based mainly on references by Turner and Hester (1985). Bulverde points have been found in the Middle Archaic period at sites 41HR315 (Patterson 1980) and 41FB42 (HAS field notes). Lange and Travis points were found in the Middle Archaic at site 41AU37 (Hall 1981).

The time span of the Gary/Kent series of dart points must be given special consideration because of the long time period involved, from the Middle Archaic through the Late Prehistoric. Gary points start in the Middle Archaic period at sites 41AU37 (Hall 1981), 41HR315 (Patterson 1980), and the Doering site (Wheat 1953). A large body of data exists for these point types then continuing through the Late Archaic, Early Ceramic, and at least some portion of the Late Prehistoric. Gary points tend to be smaller in the Early Ceramic and Late Prehistoric periods (Ensor and Carlson 1991; Patterson 1980).

The Ponchartrain point is placed in the Late Archaic on the basis of data from sites 41AU37 (Hall 1981) and 41HR315 (Patterson 1980), and its temporal placement in Louisiana (Turner and Hester 1985). It is now well established that several point types, including Ensor, Ellis, Darl, Yarbrough, Palmillas, Gary, and Kent types, are sometimes found together in both the Late Archaic and Early Ceramic periods (Patterson 1989b,1990b). The temporal placement in this chronology of Fairland and Marcos point types is based mainly on references by Turner and Hester (1985). Hall (1981) has data from Allens Creek for Fairland points in the Late Archaic. Both Fairland and Marcos are essentially Central Texas dart point types, and are not common in Southeast Texas.

Summary

A number of problems have been noted here for Ensor's (1991: Figure 1) chronology of Southeast Texas dart points. Ensor's proposed chronology has too many problems to warrant general use. The latest proposed chronology by Patterson (1990: Table 2 and Table 1 here) has also been discussed, using some key references. For many dart point types, other supporting references on chronology are available, but are too extensive to cite in an article of this length. As noted in the Introduction, chronologies should be continuously refined as new data become available. It is difficult to obtain sufficient radiocarbon dates to rigorously define the actual time range for each projectile point type. Because of slow cultural change by the prehistoric hunter-gatherers of this region, it is not always necessary to have exact time ranges for each projectile point type. Broad time periods may be used for many types of archeological studies.

References cited

Ensor, H. B.

1990 Comments on Prehistoric Chronology Building in Southeast Texas. Houston Archeological Society Journal 98:1-11

Ensor, H. B., and D. L. Carlson

1991 Alabonson Road: Early Ceramic Period Adaptation to the Inland Coastal Prairies Zone, Harris County, Southeast Texas. Archeological Research Laboratory, Texas A&M University, Reports of Investigations No. 8

Hall, G. D.

1981 Allens Creek: A Study in the Cultural Prehistory of the Lower Brazos River Valley, Texas. Texas Archeological Survey, Research Report No. 61

Patterson, L. W.

1980 The Owen Site, 41HR315: A Long Occupation Sequence in Harris County, Texas. Houston Archeological Society, Report No. 3

1988 Radiocarbon Dates from 41FB37, Fort Bend Co., Texas. Houston Archeological Society Journal 91:20-21

1989a Determination of Central Texas Prehistoric Time Periods. Texas Archeology 33(2):7-8

1989b Chronological Placement of Late Archaic and Early Ceramic Dart Point Types in Southeast Texas. Houston Archeological Society Journal 94:14-15

1989c Early Dates for the Pedernales Point. La Tierra 16(1):28-30

1990a The Seaberg Collection (41HR641,642), Harris Co., Texas. Houston Archeological Society Journal 98:12-21

1990b Relationships of Certain Dart Point Types in Southeast Texas. Houston Archeological Society Journal 96:1-4

1991 Arrow Point Chronology in Southeast Texas. Houston Archeological Society Journal 101:6-11

Patterson, L. W., and J. D. Hudgins

1987 Test Excavations at Site 41FB37, Fort Bend Co., Texas. Houston Archeological Society Journal 88:1-8

Patterson, L. W., J. D. Hudgins, R. L. Gregg, and W. L. McClure

1987 Excavations at Site 41WH19, Wharton County, Texas. Houston Archeological Society, Report No. 4

Sellards, E. H.

1940 Pleistocene Artifacts and Associated Fossils from Bee County, Texas. Bulletin of the Geological Society of America 51:1628-1657

Shafer, H. J.

1988 Archeology in the San Jacinto River Basin: A Look Back After 20 Years. In: A Collection of Papers Reviewing the Archeology of Southeast Texas, edited by P. Wheat and R. L. Gregg. Houston Archeological Society, Report No. 5

Story, D. A.

1990 Cultural History of the Native Americans. In: The Archeology and Bioarcheology of the Gulf Coastal Plain, Volume 1, by D. A. Story et al. Arkansas Archeological Survey Research Series No. 38

Turner, E. S., and T. R. Hester

1985 A Field Guide to Stone Artifacts of Texas Indians. Texas Monthly Press

Webb, C. H., J. L. Shiner, and E. W. Roberts

1971 The John Pearce Site (16CD56): A San Patrice Site in Caddo Parish, Louisiana. Bulletin of the Texas Archeological Society 42:1-49

Wheat, J. B.

1953 The Addicks Dam Site, Bureau of American Ethnology, Bulletin 154:143-252

Arrow Point Chronologies of Southeast Texas

Leland W. Patterson

Introduction

The bow and arrow became the predominant weapon system in Southeast Texas during the Late Prehistoric (A.D. 600-1500) and Historic Indian (A.D. 1500-1800) time periods, although use of the spear and spear thrower (atlatl) continued in the inland portion of this region (Aten 1983:306; Patterson 1980; Wheat 1953). There are two main problems in determining arrow point chronologies in Southeast Texas: (1) the starting date of the bow and arrow, and (2) the time ranges for each arrow point type. This article considers both of these problems.

Evidence is noted here for the introduction of the bow and arrow much earlier than the Late Prehistoric time period, and for the Perdiz point being the predominant arrow point type in Southeast Texas for the entire time span of the Late Prehistoric and Historic Indian periods. Chronologies of other major arrow point types are also discussed.

Introduction of the bow and arrow

Little research has been done on the introduction of the bow and arrow into various regions of the United States. There seems to be an accepted dogma that use of the bow and arrow started about A.D. 600 throughout most of the U.S. (Patterson 1982). However, there appears to be little interest in the origin of the bow and arrow beyond determining the introduction date. I have proposed that the bow and arrow was introduced into southern North America by diffusion from the north, and reached Southeast Texas much earlier than generally accepted dates for the start of the bow and arrow (Patterson 1982). This technological diffusion included small prismatic blade technology and use of unifacial arrow points. Excavations at site 41HR315 (Patterson 1980) indicate that unifacial arrow points started sometime near the start of the Late Archaic time period (1500 B.C.). Bifacial arrow point styles that start about A.D. 600, such as Scallorn in Central Texas and Perdiz in Southeast Texas, represent the standardization of types rather than the introduction of the bow and arrow. Unifacial arrow point styles published by Patterson (1982: Figure 1, 1980: Figures 10,13,15) are similar to specimens published by other investigators in Southeast Texas (Ensor and Carlson 1991: Figure 42S,T).

Since the early introduction of the bow and arrow into Southeast Texas has been discussed elsewhere (Patterson 1982), this article will focus on the chronologies of standardized bifacial arrow point types after A.D. 600. Comments here will concentrate on the four major arrow point types in Southeast Texas, which are Perdiz, Alba, Catahoula, and Scallorn. A number of other arrow point types, such as Bassett, Bonham, and Friley, occur in small numbers in this region. Comments will also be given on some minor arrow point types in the Historic Indian period. It is shown that Southeast Texas has a chronology of arrow point types that is different from adjacent regions.

General chronological problems

The time ranges of major arrow point types in Southeast Texas are not well defined with radiocarbon dates, as is the Scallorn-Perdiz chronological sequence in Central Texas (Prewitt 1983). Only the Perdiz point on the Southeast Texas coastal margin has a series of radiocarbon dates that cover the probable complete time range for use of this point type. For the inland portion of

Southeast Texas, excavation sequences and a few radiocarbon dates must be used to study the chronology of arrow point types.

There are two common errors made by investigators in developing arrow point chronologies for Southeast Texas. The first is a tendency to use the Scallorn-Perdiz chronological sequence of Central Texas also for Southeast Texas. There are no data to support this assumption. The second common error is to attempt to force a chronological sequence of arrow point types with little temporal overlap between types, when there is no supporting data. Ensor (1990: Figure 1) has given a proposed arrow point chronology for inland Southeast Texas that suffers from both of these types of error. Ensor's sequence of arrow point types (Catahoula-Alba-Scallorn-Perdiz) has no substantive basis, but instead appears to be wishful thinking that all arrow points fall into a serial chronological sequence.

External relationships

Lithic traditions in Southeast Texas can only be understood if consideration is given to this region as an interface between technological traditions of the Southern Plains and Southeast Woodlands. This is shown for the Late Prehistoric period in Table 1 by the geographic distributions of arrow point types within Southeast Texas. These data are from the September 1991 contents of the computerized data base for inland Southeast Texas, which has been updated since original publication (Patterson 1989, n.d.). The region of study is shown in Figure 1. The Perdiz point appears to be the only indigenous arrow point type in this region, with a fairly uniform distribution. The Scallorn point is essentially a Central Texas type, with a sharp decrease in frequency of occurrence in the eastern portion of Southeast Texas. Catahoula and Alba points are essentially Louisiana types, with sharp decreases in occurrences in the western portion of Southeast Texas. The mix of arrow point traditions in Southeast Texas has given this region an arrow point chronology which is different from that in adjacent regions.

Perdiz point chronology

Aten (1983:306) states that the bow and arrow started about A.D. 600 on the Southeast Texas coastal margin. This conclusion is based on radiocarbon dates associated with the Perdiz point. The time range for radiocarbon dates associated with the Perdiz point on the Southeast Texas coastal margin is A.D. 640-1560 (Aten 1983; Patterson 1989). Most of the data are from radiocarbon dating of Rangia shell samples.

While there are not enough radiocarbon dates to define the time range for the Perdiz point in inland Southeast Texas, there are several excavation sequences which show that the Perdiz point was used throughout the entire Late Perhistoric period and into the Historic Indian period. The same data show that the Perdiz point started at least as early as any other arrow point type in this region. Wheat (1953: Table 5) shows that the Perdiz point was found throughout the Late Prehistoric portion of the excavated sequences at the Doering and Kobs sites in Harris County. The Perdiz point was also found throughout most or all of the Late Prehistoric excavation sequences at sites 41HR315 (Patterson 1980: Table 6) in Harris County, 41WH19 (Patterson et al. 1987: Table 2) in Wharton County, 41PK69 (Ensor and Carlson 1988: Tables 18-20) in Polk County, 41HR273 (Ensor and Carlson 1991: Table 16) in Harris County, and 41FB42 (HAS field notes) in Fort Bend County.

Radiocarbon dates as late as A.D. 1560 for the coastal margin and A.D. 1585 for site 41WH19 (Patterson et al. 1987) in inland Southeast Texas indicate that the Perdiz point was still being used during the Historic Indian period.

Scallorn point chronology

There are no radiocarbon dates available to show the starting date for the Scallorn point in Southeast Texas. The Scallorn point starts about A.D. 600 and terminates about A.D. 1300 in Central Texas, shortly after the introduction of the Perdiz point to this region about A.D. 1200 (Prewitt 1983: Table 1). The time range for the Scallorn point is different in Southeast Texas than in Central Texas. Data indicate that the Scallorn point was introduced into Southeast Texas from Central Texas somewhat later than the A.D. 600 starting date for the Perdiz point in Southeast Texas, but perhaps not much later. Hall (1981:103) shows Scallorn points occurring earlier than Perdiz points at site 41AU37 in Austin County, but the earliest date for the Scallorn point at that site is A.D. 920. This date is too late for the Scallorn point to start earlier than the Perdiz point in Southeast Texas.

Data from excavation sequences indicate that the Scallorn point was in use throughout most of the Late Prehistoric period and continued into some portion of the Historic Indian period in Southeast Texas. Use of the Scallorn point thoughout most or all of the Late Prehistoric period is shown by excavation sequences at the Kobs site (Wheat 1953: Table 5) in Harris County, site 41AU37 (Hall 1981:103), and site 41FB42 (HAS field notes) in Fort Bend County. Late use of the Scallorn point in Southeast Texas is shown by associated radiocarbon dates of A.D. 1480 at site 41AU37 (Hall 1981:103) in Austin County, and A.D. 1585 at site 41WH19 (Patterson et al. 1987) in Wharton County.

Catahoula and Alba point chronologies

There are no radiocarbon dates to define the start of Catahoula and Alba arrow point types in Southeast Texas. These point types start about A.D. 600 in Louisiana (Jeter and Williams 1989:148), in the Troyville Culture of the lower Mississippi valley. Data from some excavated sites in Montgomery County show that the Catahoula point starts before the Perdiz point (Shafer 1988). However, data from other excavated sites do not support the conclusion that the Catahoula point starts before Perdiz. At site 41PK8 in Polk County (McClurkan 1968: Table 6), Alba, Catahoula, and Perdiz point types all start about the same time and all point types continue throughout most of the Late Prehistoric period. At site 41PK88 in Polk County (McClurkan 1968: Table 32), Perdiz and Alba points start earlier and continue throughout the Late Prehistoric period, with Catahoula points found only in upper, later excavation levels. At the Kobs site (Wheat 1953: Table 5) in Harris County, Catahoula and Perdiz points start at the same time and continue throughout the Late Prehistoric. At the nearby Doering site (Wheat 1953: Table 5), the Perdiz point starts at the beginning of the Late Prehistoric and continues throughout this period, while the Catahoula point is only found at upper, later excavation levels. It should be noted that Wheat referred to the Catahoula point type as "Alba Barbed." At site 41HR273 (Ensor and Carlson 1991: Tables 15-17) in Harris County, Alba and Catahoula points are found throughout most of the excavation sequence for the Late Prehistoric.

Arrow points in the Historic Indian period

Data have been presented above to show that Perdiz and Scallorn point types were used in the Historic Indian period. There are data from Wharton County that show use of other arrow point types in the Historic Indian period. At site 41WH8 (Hudgins 1984), Cuney, Fresno, Guerrero, and Bulbar Stem arrow points occur in a large surface collection that definitely represents the Historic Indian period. None of these are major arrow point types in Southeast Texas.

Discussion and summary

It is concluded that the Perdiz point is probably the only indigenous arrow point type in Southeast Texas, and that this point type starts at least as early as any other major arrow point type in this region. It is also concluded that all four major arrow point types in Southeast Texas (Alba, Catahoula, Perdiz, Scallorn) were in concurrent use over most of the Late Prehistoric period. This is probably a disappointing conclusion for many archeologists who were hoping for a well-defined serial sequence of arrow point types in Southeast Texas for use as a chronological guide to subperiods within the Late Prehistoric. There is a good theoretical scenario for the general lack of a chronological sequence for major arrow point types in Southeast Texas. The situation is due to there being only one indigenous arrow point type (Perdiz), with other major types being introduced from adjacent regions and then all being used concurrently. There are a number of other excavated sites that are not cited here where the major arrow point types occur almost randomly in various portions of the Late Prehistoric time period. The body of data is now too large to simply dismiss these data because of possible stratigraphic mixing.

Another general indication of the concurrent use of the four major arrow point types in Southeast Texas can be shown by the frequencies of point type occurrences at individual sites, either with more than one point type together or with one point type alone (Table 2). For the entire inland portion of Southeast Texas, the Perdiz point is found alone at only 32% of the sites having this point type. The proportion of sites that have only Scallorn points is 27%, the proportion of sites with only Catahoula points is 9%, and the proportion of sites with only Alba points is 8%. Thus, there is a much higher proportion of sites where each major arrow point type occurs together with other arrow point types rather than alone. There appears to have been much interaction between cultural groups in this region and adjacent regions during the Late Prehistoric time period.

It has been noted here again that there is evidence for earliest use of the bow and arrow in Southeast Texas with unifacial arrow points. Bifacial arrow points represent a later standardization of technology.

Chronological constructs are seldom static. Future additional data may refine some of the items discussed here. However, the long time ranges for use of various arrow point types should come as no surprise where conservative hunter-gatherers are involved. There are even longer technological traditions in Southeast Texas, such as the Gary-Kent dart point series and Goose Creek sandy paste pottery.

References cited

Aten, L. E.
1983 Indians of the Upper Texas Coast. Academic Press

Ensor, H. B.
1990 Comments on Prehistoric Chronology Building in Southeast Texas. Houston Archeological Society Journal 98:1-11

Ensor, H. B., and D. L. Carlson
1988 The Crawford Site, 41PK69: Central Trinity River Uplands, Polk County, Texas. Texas State Department of Highways and Public Transportation, Contract Reports in Archaeology, Report No. 4
1991 Alabonson Road: Early Ceramic Period Adaptation to the Inland Coastal Prairie Zone, Harris County, Southeast Texas. Archeological Research Laboratory, Texas A&M University, Reports of Investigations No. 8

Hall, G. D.
1981 Allens Creek: A Study in the Cultural Prehistory of the Lower Brazos River Valley, Texas. Texas Archeological Survey, Research Report No. 61

Hudgins, J.D.
1984 A Historic Indian Site in Wharton County, Texas. Bulletin of the Texas Archeological Society 55:29-51

Jeter, M. D., and G. L. Williams, Jr.
1989 Ceramic Using Cultures, 600 B.C.-A.D. 700. In: Archeology and Bioarcheology of the Lower Mississippi Valley and Trans-Mississippi South in Arkansas and Louisiana, by M. D. Jeter et al. Arkansas Archeological Survey, Research Series No. 37

McClurkan, B. B.
1968 Livingston Reservoir, 1965-66: Late Archaic and Neo-American Occupations. Papers of the Texas Archeological Salvage Project, No. 12

Patterson, L. W.
1980 The Owen Site, 41HR315: A Long Occupation Sequence in Harris County, Texas. Houston Archeological Society, Report No. 3

1982 Initial Employment of the Bow and Arrow in Southern North America. La Tierra 9(2):18-26

1989 A Data Base for Inland Southeast Texas Archeology. Houston Archeological Society. Report No. 6

n.d. The Archeology of Inland Southeast Texas: A Quantitative Study. Bulletin of the Texas Archeological Society, in press

Patterson, L. W., J. D. Hudgins, R. L. Gregg, and W. L. McClure
1987 Excavations at Site 41WH19, Wharton County, Texas, Houston Archeological Society, Report No. 4

Prewitt, E. R.
1983 From Circleville to Toyah: Comments on Central Texas Chronology. Bulletin of the Texas Archeological Society 54:201-238

Shafer, H. J.
1988 Archeology of the San Jacinto River Basin: A Look After 20 Years. In: A Collection of Papers Reviewing the Archeology of Southeast Texas, edited by P. Wheat and R. L. Gregg. Houston Archeological Society, Report No. 5, pp. 17-21

Wheat, J. B.
1953 The Addicks Dam Site. Bureau of American Ethnology, Bulletin 154:143-252

Table 1. Arrow Point Distribution in Southeast Texas
(major types only)

	western		central		eastern	
point type	no. of points	no. of sites	no. of points	no. of sites	no. of points	no. of sites
Perdiz	77	26	300	40	410	35
Scallorn	58	20	53	19	9	5
Catahoula	2	2	82	20	115	25
Alba	7	6	20	13	274	30

Table 2. Arrow Point Occurrence Frequencies in Southeast Texas

	number of sites			
	west	central	east	total
total Perdiz	26	40	35	101
total Scallorn	20	19	5	44
total Catahoula	2	20	25	47
total Alba	6	13	30	49
Perdiz alone	11	18	3	32
Scallorn alone	5	7	0	12
Catahoula alone	0	4	0	4
Alba alone	0	4	0	4
all 4 types	0	3	3	6
Perdiz-Scallorn	8	4	0	12
Perdiz-Catahoula	0	6	3	9
Perdiz-Alba	1	2	8	11
Catahoula-Alba	0	1	2	3
Perdiz-Scallorn-Catahoula	2	4	1	7
Perdiz-Scallorn-Alba	4	1	1	6
Scallorn-Catahoula-Alba	0	0	0	0
Scallorn-Catahoula	0	0	0	0
Scallorn-Alba	1	0	0	1
Perdiz-Catahoula-Alba	0	2	16	18

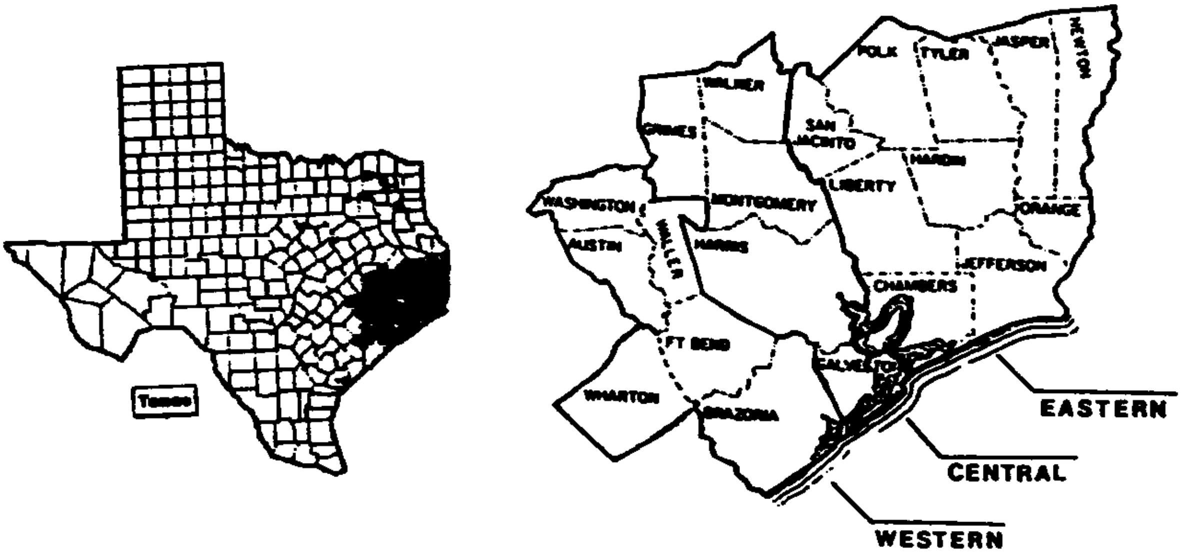

Figure 1. Southeast Texas study area

Dynamics of the Trinity Delta

Subsidence and Accretion For The Last 5,000 Years

C. R. Ebersole

The global seas reached their present level a little over 5,000 years before the present (Nelson and Bray 1979). At that time the Texas coast was an erose drowned coastline, somewhat analogous to the shore of Chesapeake Bay today (Fisher etal. 1973). Sand carried down the rivers of the coast built up, at the edge of the coast and parallel to it, a series of bars cut by narrow passes and the present fairly regular coastal configuration was the result, the bars being the present peninsulas and islands along the Texas coast, Bolivar and Galveston typical of the lot.

Along part of the coast, for instance from Sabine Pass to High Island and from San Luis Pass to East Matagorda Bay, the areas behind these bars have filled to some extent with sediment, creating a marshland now being drained for agricultural purposes. In others shallow bays lie behind the bars. The largest of these bays is Galveston Bay.

The two principal tributaries to Galveston Bay are the San Jacinto River (fed in part by Buffalo Bayou) and the Trinity River. A delta covers the ancient mouth of the Trinity. The River empties into an arm of Galveston Bay called Trinity Bay and henceforth my references to "the River" are to the Trinity and to "the Bay" are to Trinity Bay. This essay is about the Trinity delta.

Trinity Bay is a sort of trapezoid, its northwest boundary being the shoreline running northeast along a high (30 feet or so) bluff from the base of Mesquite Point just east of the mouth of Cedar Bayou to the end of the bluffs at the settlement of Barrow (where McCollum Park is located). From there the bay runs almost due east for about four miles to deltaic islands along the west side of the River. A number of bayous run south into the bay along this shore, Red Bayou, Cross Bayou, Long Island Bayou, and others. From this point the shore of the bay runs southeast past the delta and the eastern shore of Chambers County to Smith Point, and this is the eastern side of the trapezoid. The final side of the bay is a line across the waters from Smith Point to Mesquite Point.

The Galveston Bay Archeological Survey is an unfunded survey of the shores of Galveston Bay, including Trinity, East, and West Bays. The persons who have participated in the work so far have been Captain Dr. C. R. Ebersole, Professor Sheldon Kindall, Sgt. Michael Marshall, and Dr. Richard L. Gregg. In the course of the survey previously reported sites are visited and reported on, and original reports are made on the unreported ones. These unreported sites are in the main shell middens formed from the time the sea reached its present point to now.

There are at least 100 sites along the shores of Trinity Bay and in the swampy delta behind them. They are usually found at the mouths of the rivers and bayous flowing into Galveston Bay and its arms, and are formed for the most part of Rangia clam shells. These molluscs live in brackish rather than salty water, and there is often an admixture of oyster shells, particularly as saltier water of the Gulf is neared. Clams are meatier and have more nourishment per weight than oysters and this would appear to be the principal reason for location of the middens near the clam beds.

When, at the beginning of the summer of 1990, the members of the survey reached the great marsh lying to the north of the Bay and began a journey eastward along this strand, it was expected that middens would be found at the mouth of most if not all of the bayous entering the bay. A long midden was found and reported (41CH287) at the north side of McCollum Park, but none were found at the mouths of Red Bayou and Double Bayous and two unnamed bayous between these streams. A previous investigator had found and reported a midden (41CH163) at the mouth of Cross Bayou but there were none at the mouths of two tiny streams to the east of it, or at Dunn Bayou, or at any of the inlets to the east of it on over to Cove Bayou, where there was a long north-south midden (41CH299) on a ridge running out into the Bay from the west bank of the bayou. The water was very shallow along the entire stretch from McCollum Park to the mouth of the River and the reconnaissance was made by two of these foolish men who waded along the shore while a third pulled the Archeological Research Skiff "ARTIFACT" offshore a hundred meters or so.

About 1-1/2 miles east of Cove Bayou, at the mouth of Long Island Bayou, the character of the shore changed. The bayshore from here went southeast and then south to the mouth of the River south of the town of Anahuac. The bayous and such were Garden Bayou, Jack's Bay and Jack's Pass, Blind Bayou, Big and Little Triangle Passes, Southwest Pass, Bulkhead Cove, Old River, King's and Brown's Passes, and finally the River itself. This series of bayous and passes were all streams or relief channels running between the River and the Bay in a south or southwest direction.

There were no middens at the mouths of these places either except for one (41CH312) near the mouth of Old River Pass on a tiny knoll which the author believes to be a former islet now surrounded by new silt and part of a larger island (U. S. Coast Survey 1851). However, a number of middens were found inland from the mouths of these streams (41CH126, 127, 128, 308, 310, 309, and 313). The streams are usually called "passes," and are relief channels that take some of the water from the River at all times and at flood times take large amounts and occasionally become principal mouths of the River themselves.

So there you have it. There were no middens where they logically could be expected to occur and there are middens where they should not logically be expected. Why?

The explanation seems to me to be that along the west part of the area here under consideration, that is, the west part of the delta, there has been much subsidence from oil and gas fields discovered in the 1930s in Trinity Bay and produced since that time. There are a number of large fields in the Bay, the Trinity Bay Field, West Trinity Bay, Fishers Reef, North and South Fishers Reef, Umbrella Point, and others. Another large field, the Cotton Lake Field, lies to the west of the delta. Production figures from the fields (approaching 100 million barrels of liquids plus hundreds of millions of cubic feet of gas) are deceptive because, in addition to large amounts of oil and gas removed, large amounts of salt water were produced, and no very accurate figures on this production are available or probably in existence, the water being poured into the Bay and its tributaries until rather recent times. A good bit of it still makes its way into these waters, legally and illegally. The result of this production of liquids and gases has been subsidence, and an already low coast was made yet lower.

The Edgar Tobin Mapping Company of San Antonio made, in 1960, from aerial photographs, an ownership map of Chambers County (Tobin 1960). Like most maps, it is based on older maps in part and on the patents (a deed from the sovereign) and deeds covering the land found in archives in Austin and in the Chambers County Courthouse. This land was patented to Solomon Barrow and Joseph Lawrence in 1847. There were later deeds and partitions and these indicate, and the Tobin Company so shows on its map, that the coastline was once one to three hundred feet farther out into the Bay than it is now, from the Barrow Community as far east as Long Island Bayou (called Mud Bayou on the Tobin map). It is my belief that there were once and probably are now middens at the mouth of the bayous flowing south from Cotton and Old River Lakes into the Bay but that these middens are now submerged due to this subsidence. During a stiff norther in the winter of 1991 a large midden was found extending south from the west mouth of Cross Bayou (CH330). The weather prevented further exploration but it is believed that there are additional submerged middens reaching out at right angles into the bay from the mouths of the other bayous emptying into it along this coast.

As the coastline turns south and east at the mouth of Long Island Bayou the coastline has extended. The 1851 U. S. Coast Survey map of Trinity Bay shows the deltaic lands running along the right bank of the Trinity to have been much smaller then than they are now. Settlement by European farmers of the Trinity River basin, up into North Texas, was begun soon after the Revolution. The denuding of the forests and the plowing of the land sent large parts of our state down the River as mud, much of which dropped from the water at the mouths of the River. This still continues but to a much lesser extent since the construction of dams in the basin and the adoption of better farming practices.

The result of the movement of silt down the River was an extension of the delta of the River, not only along the main channel but also along the lesser mouths, along the passes and sloughs. The middens that were originally at the mouth of these places, at the junction of the fresh and salt waters into the brackish mix preferred by the Rangia clam, are now about halfway down the passes and the new mouths of the passes are bare. The growth of the delta can be seen by comparing modern maps of the delta (USGS 1961) with the 1851 Coast Survey map (U. S. Coast Survey 1851).

References cited

Fisher, W. L., L. F. Brown, J. H. Mc Gowen, and C. G. Groat

1973 Environmental Geologic Atlas of the Texas Coastal Zone, Bureau of Economic Geology, The University of Texas at Austin, Austin, Texas

Nelson, H. F., and E. E. Bray

1979 Stratigraphy and History of the Holocene Sediments in the Sabine-High Island Area, Gulf of Mexico. In: Deltaic Sedimentation, Modern and Ancient, edited by J. P. Morgan and R. H. Shavers. Society of Economic Paleontologists and Mineralogists Special Publication No. 15, pp 48-77

Tobin

1961 Map of Chambers County, Texas. The Edgar Tobin Mapping Company, San Antonio, Texas

U. S. Coast Survey

1851 Map of the Texas Coast, Galveston Bay from Lawrence Cove to Stevenson's. Ms. map T-330, U. S. Coast and Geodetic Survey

USGS

1961 Topographic quadrangle maps "Cove" (2994-331) and "Anahuac" (2994-342), photorevised in 1984

Molluscan Shells from 41FB32: Environmental, Cultural, and Taphonomic Observations

Raymond W. Neck

Houston Museum of Natural Science

Introduction

Test excavations of several archeological sites along the San Bernard River have revealed utilization of the banks of this stream as temporary campsites by nomadic hunter-gatherers during the Archaic period (Patterson and Hudgins 1986, 1987). The occurrence of well-preserved faunal remains has indicated utilization of both vertebrate (McClure 1986, 1989) and molluscan resources (Neck 1986).

Molluscan remains recovered from 41FB32 are presented below. This Middle and Late Archaic site is located on a high ridge that protrudes from the high main terrace of the left bank of the San Bernard River in western Fort Bend County, Texas. The shell material had been screened through 1/4-inch screen before being presented to the author. One column (a 10 by 10 cm section of pit F) had been screened through window screen to facilitate recovery of small snail shells. Excavation details are provided by Patterson and Hudgins (1988).

Molluscan species analysis

A total of two freshwater snail species, 10 terrestrial snail species, and 10 freshwater mussel species are represented in the molluscan shell remains recovered from 41FB32.

The terrestrial snails are the larger-shelled species that occur in east central Texas. Smaller-shelled species were not recovered except from the special column in pit F. The most abundant species recovered include *Oligyra orbiculata*, a terrestrial operculate that ranges over most of eastern and central Texas; *Rabdotus dealbatus*, a large-shelled pulmonate that is found in riparian corridors of eastern and central Texas; and two species of *Praticolella* (*P. berlandieriana* and *P. pachyloma*) that occur in central and east central Texas.

Only two species of freshwater snails are represented in the present samples. *Planorbella trivolvis* is a wide-ranging pulmonate with records from Mexico northward to Canada. *Campeloma crassula* is found in slow-moving streams which have a sandy substrate and slightly acidic water.

The freshwater mussels are species that occur in the Coastal Plain segment of the Brazos and Colorado Rivers, the rivers on either side of the drainage of the San Bernard River. No published records of freshwater mussels are known from the San Bernard River, but this author is currently conducting a survey of living freshwater bivalves of the San Bernard River.

Overall, the mussels represent several habitats (differing in substrate, current, or depth of water) that are represented in a segment of a slow-moving river with a soft substrate (sand or mud). Several species originated from slow-moving sloughs (*Toxolasma texasensis*) or temporary pools (*Uniomerus declivus*). Species such as *Amblema plicata*, *Quadrula apiculata*, and *Potamilus purpuratus* indicate a permanent stream with "moderate" water flow.

Environmental reconstruction

The terrestrial gastropods are dominated by two species, *Oligyra orbiculata* and *Praticolella pachyloma*, with somewhat different habitat requirements. *O. orbiculata* is found in a wide variety of habitats with cover in the form of rocks or wood. Woody vegetation is normally present in areas that support *O. orbiculata*. *P. pachyloma* is characteristic of deep sandy soils; vegetation cover may be an open woodland or grassland. For most of the excavated pits, numbers of *O. orbiculata* peak in levels toward the bottom of these excavations, whereas *P. pachyloma* tends to peak in the upper or middle levels. The distribution of these two species indicates the presence of a heavy riparian woodland during the time of deposition of the lower levels. This habitat became more open through time as the increased levels of *P. pachyloma* indicate. This change in habitat could have resulted from ecological succession related to river hydrodynamics, changes in climatic regime, or anthropogenic impact.

The fine-screened column from pit F provided several additional species of gastropods with shells too small to be retained by 1/4-inch screen. These additional species indicate the occurrence of wooded habitats in the area throughout the time of deposition of sediments excavated from pit F. The greater number of species indicative of mesic habitat in the lower portion of the column verifies the occurrence of a more heavily developed riparian woodland at this time period.

The San Bernard River may have had a greater and more stable water volume than at present. This increased volume is indicated not only by the relatively large numbers of freshwater mussels present in these samples but also by the large size of some of these shells.

The distribution of *Praticolella berlandieriana* may also provide further clues to the paleoenvironmental record of this site. In general, *P. berlandieriana* peaks in abundance at a slightly lower stratigraphic level than *P. pachyloma*. The major difference in habitat requirements of these two congeneric species is soil preference. *P. pachyloma* is always found on sandy soils, whereas *P. berlandieriana* prefers clay or loamy soils. Since the terrace material at 41FB32 has been described as entirely sandy soil (Patterson and Hudgins 1987), the area of 41FB32 would not appear to have been suitable habitat for *P. berlandieriana* during the depositional history of this site. These *P. berlandieriana* shells are more likely to have originated as flood debris. The living populations of *P. berlandieriana* probably were located in disturbed margins of the adjacent Coastal Prairie that are underlain by clay soils.

The unionid assemblage recovered from 41FB32 is slightly more diverse and includes larger individuals than are found in the San Bernard River today. Significant causal factors could involve climatic change or recent human impact. Further field surveys on the living fauna are required before a conclusive decision between these two factors can be made. Similar factors, however, were probably involved in the regional extirpation of a vole, *Microtus* sp., that is currently extralimital (McClure 1989). In the case of the unionid fauna decline in species richness and individual size, historical records of unionids with voucher specimens in museum collections tend to implicate both climatic and recent human impact as the causal factor.

Cultural utilization

Freshwater mussels recovered from 41FB32 exhibit signs of cultural utilization by the prehistoric human inhabitants.

The flesh of the three ridge, *Amblema plicata*, was intensively used as food at 41FB32. Some shells were broken so that the posterior one-fourth to one-half of the shell was removed. Many of the pieces are charred, and these pieces are generally smaller than those pieces that are uncharred. Additional shells of *A. plicata*, however, are entire and provide no indication of utilization as food. However, the relatively thick shells of *A. plicata* could have been heated sufficiently to open the valves without charring the shells.

The small freshwater mussel, Texas lilliput – *Toxolasma texasensis* – is found throughout the sediments of 41FB32. However, relatively few of these shells are charred; either this species was underutilized as food (possibly due to its small size) or the thin, charred shells of this species disintegrated into unrecoverable pieces through time. The occurrence of articulated pairs of this species as well as entire single valves indicates that many, if not most, *T. texasensis* shells at 41FB32 represent natural flood debris deposits.

Two pieces of *A. plicata* from pit C, level 8, may represent pieces of shell that were modified prior to or during use of these fragments. These mussel shell fragments have a rounded margin that has been worn to a sharp edge. These shell tools could have been used as scrapers in a number of situations.

Several shell fragments are pieces of ornaments. Four valves of small-sized *Amblema plicata* (from pit C, level 8; pit D, levels 5 and 6) each have a single hole below the umbo that appears to have been produced by rubbing the beak area against a resistant object. Two valves of *Lampsilis hydiana* (from pit C, level 8; pit D, level 5) each have a single hole through the shell below the interdentum or in the middle of the shell. The holes in *L. hydiana* appear to have been drilled rather than scraped. All of these shell fragments could then be attached to clothing or other cultural objects for ornamentation or noise production.

Taphonomic observations

Analysis of the charred valves revealed taphonomic processes that could result in an underestimation of the utilization of *Amblema plicata* as food. The percentage of small valve fragments (including isolated pseudocardinal teeth) that are charred is larger than the percentage of nearly entire (or at least one-half valve) valves that are charred. This disparity indicates that charred shells are more likely to disintegrate than are uncharred shells. Heating of the calcium carbonate in the shells converts a portion of it into lime (calcium oxide) by driving off carbon dioxide. Although this conversion is incomplete, the remaining shell material is more friable and will disintegrate much faster than unaltered shell material. Only the thicker portions that were slower to heat, i.e., the massive pseudocardinal teeth of *A. plicata*, will remain.

Another taphonomic process was noted in pit F. A large number of valves of *Amblema plicata* exhibited signs of water leaching. Groundwater moving through the sandy alluvium at 41FB32 will tend to slowly dissolve calcium carbonate. The upper drainage basin of the San Bernard River lacks bedrock with large amounts of calcium carbonate. Thus, even the water in the San Bernard River is deficient in this mineral and will tend to dissolve it. Certainly any local aquifer from the immediate area of 41FB32 will not be saturated with this mineral. Since pit F is the highest in elevation of the pits at 41FB32, this leaching was probably caused by direct rainfall infiltration into the lower soil layers. Following a long period of water leaching, freshwater mussel shells become chalky in appearance. Loss of shell integrity is not as rapid as following heating, but water-leached shells are more friable than shells remaining in dry sediments. This leached calcium carbonate could be the source of the carbonate layer that is observed in the lower soil layers in some sites in this area.

Summary

Identification and analysis of molluscan remains from 41FB32 have revealed a well-developed riverine fauna of mussels and gastropods. The lateral terrace was covered with a closed or open gallery woodland. Water volume in the San Bernard River was apparently greater and more seasonally constant than under modern conditions. Human occupants of this site utilized freshwater mussels as food, ornaments, and tools. Taphonomic processes detected involved differential survival of untreated, charred, and water-leached shell. Some of the impact on shell integrity may have occurred during the recovery process. Care should be taken to handle shell material carefully; notes on shell condition prior to screening would be valuable.

References cited

McClure, W. L.

1986 Faunal Analysis of 41FB34. Houston Archeological Society Journal 86:1-7

1989 The Vertebrates of 41FB32. Houston Archeological Society Journal 93:15-21

Neck, R.

1986 Analysis of Molluscan Remains Recovered from 41FB34, Fort Bend Co., Texas. Houston Archeological Society Journal 86:8-10

Patterson, L. W., and J. D. Hudgins

1986 Test Excavations at Site 41FB34, Fort Bend Co., Texas. Houston Archeological Society Journal 85:1-7

1987 Test Excavations at Site 41FB32, Fort Bend Co., Texas. Houston Archeological Society Journal 87:12-19

Table 1. Summary of molluscan shells from pit A, 41FB32; 1+1 = adult + immature

	Levels					
	2*	3	4	5	6	7
Gastropods						
Oligyra orbiculata		4	24	30	120	126
Campeloma crassula						
Planorbella trivolvis						1+0
Pupoides albilabris						
Gastrocopta contracta						
Helicodiscus singleyanus						
Glyphyalinia umbilicata						
Rabdotus dealbatus		1	1	2	14	11
Polygyra auriformis					2	
Praticolella berlandieriana						
Praticolella pachyloma		39	49	24	30+5	16
Mesodon thyroidus						
Bivalves						
Anodonta grandis						1
Amblema plicata		40	15	17	102	52
Quadrula apiculata		2				1
Cyrtonaias tampicoensis						
Lampsilis hydiana						
Lampsilis teres						
Leptodea fragilis						
Potamilus purpuratus					2	
Toxolasma texasensis		15	19	8	28	19
Uniomerus declivus			1			

*only unidentifiable unoinid fragments present in level 2

Table 2. Summary of molluscan shells from pit B, 41FB32

	Levels							
	2	3	4	5	6	7	8	9
Gastropods								
Oligyra orbiculata	8	6	43	106	25	58	47	44
Campeloma crassula								
Planorbella trivolvis								
Pupoides albilabris								
Gastrocopta contracta								
Helicodiscus singleyanus								
Glyphyalinia umbilicata								
Rabdotus dealbatus			2	11	1	5	5	1
Polygyra auriformis				1		1	1	
Praticolella berlandieriana			35	47	56	68	94	25
Praticolella pachyloma	62	135	197	10	30	19	19	9
Mesodon thyroidus				2		1	1	
Bivalves								
Anodonta grandis	1							
Amblema plicata	2	9	8	19	3	6	9	17
Quadrula apiculata			1					
Cyrtonaias tampicoensis								
Lampsilis hydiana								
Lampsilis teres								
Leptodea fragilis				1	1		1	2
Potamilus purpuratus	2			2		2		
Toxolasma texasensis			8	18	1	2	10	12
Uniomerus declivus								

Table 3. Summary of molluscan shells from pit C, 41FB32

	Levels					
	3	4	5	6	7	8
Gastropods						
Oligyra orbiculata	2	1	1	1	2	
Campeloma crassula					1	
Planorbella trivolvis						
Pupoides albilabris						
Gastrocopta contracta						
Helicodiscus singleyanus						
Glyphyalinia umbilicata						
Rabdotus dealbatus			3	1	11	7
Polygyra auriformis						
Praticolella berlandieriana	7	6	3	1	1	
Praticolella pachyloma			3			
Mesodon thyroidus				1	1	
Bivalves						
Anodonta grandis						
Amblema plicata	4	8	8	16	30	46
Quadrula apiculata						1
Cyrtonaias tampicoensis			1			
Lampsilis hydiana					3	10
Lampsilis teres	2	1		1		5
Leptodea fragilis					1	
Potamilus purpuratus	2	2			1	
Toxolasma texasensis		2	5	6	23	41
Uniomerus declivus						

Table 4. Summary of molluscan shells from pit D, 41FB32

	Levels				
	2	3	4	5	6
Gastropods					
Oligyra orbiculata		95	174	229	36
Campeloma crassula					
Planorbella trivolvis			1	1	
Pupoides albilabris					
Gastrocopta contracta					
Helicodiscus singleyanus					
Glyphyalinia umbilicata					
Rabdotus dealbatus	1	12	27	26	19
Polygyra auriformis					
Praticolella berlandieriana	5	5	29	12	9
Praticolella pachyloma		63	13	2	
Mesodon thyroidus		3			
Bivalves					
Anodonta grandis			1		
Amblema plicata	8	43	42	73	44
Quadrula apiculata				1	1
Cyrtonaias tampicoensis			1	5	
Lampsilis hydiana			5	8	17
Lampsilis teres		8	1		1
Leptodea fragilis				1	
Potamilus purpuratus			5	6	4
Toxolasma texasensis	2	27	49	92	126
Uniomerus declivus					

Table 5. Summary of molluscan shells from pit E, 41FB32

	Levels									
	7	8	9	10	11	12	13	14	15	16
Gastropods										
Oligyra orbiculata				13	13					
Campeloma crassula				1						
Planorbella trivolvis										
Pupoides albilabris										
Gastrocopta contracta										
Helicodiscus singleyanus										
Glyphyalinia umbilicata										
Rabdotus dealbatus	1					2		3	1	
Polygyra auriformis										
Praticolella berlandieriana			2							
Praticolella pachyloma	2	8								
Mesodon thyroidus	1	1	2		1					
Bivalves										
Anodonta grandis										
Amblema plicata	1	1	3	31	39	27	1	3	2	1
Quadrula apiculata										
Cyrtonaias tampicoensis										
Lampsilis hydiana				1		3		5		
Lampsilis teres										
Leptodea fragilis										
Potamilus purpuratus										
Toxolasma texasensis		1		2	3	1		1	3	2
Uniomerus declivus										

Table 6. Summary of molluscan shells from pit F, 41FB32

	Levels								
	9	10	11	12	13	14	15	16	17
Gastropods									
Oligyra orbiculata	2								
Campeloma crassula									
Planorbella trivolvis									
Pupoides albilabris									
Gastrocopta contracta									
Helicodiscus singleyanus									
Glyphyalinia umbilicata									
Rabdotus dealbatus			1	2					
Polygyra auriformis									
Praticolella berlandieriana		2							
Praticolella pachyloma									
Mesodon thyroidus			1						
Bivalves									
Anodonta grandis									
Amblema plicata		1	26	24	8	1	11	11	3
Quadrula apiculata							1		
Cyrtonaias tampicoensis									
Lampsilis hydiana			1				2	1	1
Lampsilis teres									1
Leptodea fragilis									
Potamilus purpuratus				1					
Toxolasma texasensis				1	4	4	10	11	4
Uniomerus declivus									

Table 7. Summary of molluscan shells from pit F, 10 by 10 cm unit

	Levels								
	0-8	9-10	10-11	11-12	12-13	14-15	15-16	16-17	17-18
Gastropods									
Oligyra orbiculata		1	1	6	8	18		5	
Campeloma crassula									
Planorbella trivolvis									
Pupoides albilabris	18	1				3	1		
Gastrocopta contracta	2	1			1				
Helicodiscus singleyanus				1	1	2	3		
Glyphyalinia umbilicata			1			4			
Rabdotus dealbatus				1		7	1		
Polygyra auriformis									
Praticolella berlandieriana	8	1				4	1	2	
Praticolella pachyloma	10								
Mesodon thyroidus									
Bivalves									
Anodonta grandis									
Amblema plicata			1		1	4	4	1	
Quadrula apiculata									
Cyrtonaias tampicoensis									
Lampsilis hydiana									
Lampsilis teres									
Leptodea fragilis									
Potamilus purpuratus									
Toxolasma texasensis		1		1	1	17	3	2	1
Uniomerus declivus									

Vertebrates of Site 41WH12

W. L. McClure

Introduction

Site 41WH12 was tested by members of the Houston Archeological Society and details of the excavation, artifacts, and dating are discussed in the Houston Archeological Society Journal 95. The site is on the east bank of Peach Creek, a tributary of the San Bernard River in Wharton County, Texas. Occupation of the site was from the latter part of the Late Archaic into the Historic period (Patterson and Hudgins 1989).

All soil that was excavated was passed through 1/4-inch mesh screens and the vertebrate remains that were recovered and those from surface collections are reported here.

Methods

The bones and scales of vertebrates were identified by direct comparison with remains of known animals that are in the comparative collections of the Houston Archeological Society and of the author.

Results

More than 3100 bones and scales and fragments thereof were recovered with the total weight being nearly 4 kg. Condition of the bones was good. About 5% had been burned and a few had been gnawed by rodents. Except for the smaller, more compact bones, all were fragmented. However, this group included relatively more ends of bones than was the case in other prehistoric sites along the San Bernard drainage.

Charred shells of black walnut (*Juglans nigra*) were recovered below 15 cm in two pits.

The vertebrates that were identified include 3 fishes (158 bones and scales), 1 amphibian (2 bones), 7 reptiles (449 bones), 7 mammals (310 bones), and 3 bones of birds. More than 2200 other fragments were not identified but most would be of the size of deer bones, with a few others being of smaller mammals.

In addition to the two bone tools reported by Patterson and Hudgins (1989 p. 5, Figure 2), there were two more bones that had been modified. An awl made from a leg bone of a deer was in Pit A between 18 and 25 cm (Figure 1). About the same level in Pit D there was a midsection of a metatarsal of a deer that appears to be the result of a failed effort to make a tool. The bone had been grooved around three sides and then exposed to bending pressure. The fracture did not follow the grooves, thus producing the item in Figure 2.

Species list

Atractosteus spatula	alligator gar
Amia calva	bowfin
Aplodinotus grunniens	freshwater drum
Rana catesbeiana	bullfrog
Alligator mississippiensis	alligator
Kinosternon sp.	mud turtle
Terrapene carolina	three-toed box turtle
Trachemys scripta	red-eared slider

Trionyx sp.	softshell turtle
Elaphe sp.	rat snake
Agkistrodon piscivorus	cottonmouth
genus unknown	bird
Didelphis virginiana	opossum
Sylvilagus aquaticus	swamp rabbit
Sylvilagus floridanus	cottontail
Sigmodon hispidus	hispid cotton rat
Procyon lotor	raccoon
Odocoileus virginianus	white-tailed deer
Bos and/or *Bison*	cow and/or bison

Species Accounts

Fishes:

Gar scales and bones were recovered from the surface to 45 cm in eight pits. Very large and small individuals are included. There are 11 bones of the head, 23 vertebrae (including one ultimate vertebra), and 62 scales. Some of the head bones are of the alligator gar (*Atractosteus spatula*) and some of the other material may be of species of the genus *Lepisosteus.*

Bowfin (*Amia calva*) remains are only 2 vertebrae that were recovered from one pit between 15 and 30 cm.

The only definite bone of the freshwater drum (*Aplodinotus grunniens*) is an anal pterygiophore which was recovered below 25 cm.

Fish bones that were not identified as to variety include 37 vertebrae, 2 pterygiophores, and 20 other fragments. These are all of the subfamily Teleostei and most are probably of freshwater drum. They came from six pits between the surface and 50 cm.

Amphibians:

Only one species of amphibian was recovered. A vertebra and a tibiofibula of the bullfrog (*Rana catesbeiana*) were from two pits between 15 and 30 cm.

Reptiles:

Alligator (*Alligator mississippiensis*) bones were found at the surface and between 15 and 25 cm in one pit. The bones are 2 vertebrae, 1 dermal bone, and 2 fragments of the skull.

Mud turtle (*Kinosternon* sp.) bones are 11 fragments of the carapace and came from four pits between 15 and 35 cm. None of the material is complete enough to determine which species of the genus is represented.

Box turtle bones totaled 121, the majority being fragments of carapace with a few of plastron and 2 scapulae, a humerus, and a femur. The nuchals are of the three-toed box turtle (*Terrapene carolina*), but other bones may be of ornate box turtles (*T. ornata*). They were recovered from eight pits from the surface to 50 cm.

Red-eared turtle (*Trachemys scripta*) bones are primarily of the carapace and were in seven pits from the surface to 50 cm. It is possible that some of these 76 bones and fragments are of the Texas river cooter (*Pseudemys texana*).

A scapula and 11 fragments of carapace and plastron of the softshell turtle (*Trionyx* sp.) came from four pits from the surface to 25 cm. These are probably of the spiny softshell (*T. spiniferus*) since smooth softshells (*T. muticus*) would not be expected in Peach Creek.

At least 211 other fragments of turtle bones were included in the assemblage but they could not be assigned to particular varieties with confidence. However, species other than the above are not believed to be included. They were from eight pits from the surface to 50 cm.

Six vertebrae of rat snake (*Elaphe* sp.), 1 vertebra of cottonmouth (*Agkistrodon piscivorus*), and 1 vertebra of an unidentified snake were in three pits between 20 and 40 cm.

Birds:

Three bones of unidentified birds are 2 coracoids and a humerus from two pits between 15 and 20 cm.

Mammals:

Bones of the opossum (*Didelphis virginiana*) are 3 mandibles and an innominate from three pits between 10 and 32 cm.

Swamp rabbit (*Sylvilagus aquaticus*) bones are 2 maxillae, mandible, scapula, humerus, 2 innominates, and tibia from the surface to 30 cm in two pits. Cottontail (*Sylvilagus floridanus*) bones are 2 mandibles, tooth, 2 innominates, sacrum, astragalus, calcaneus, and metatarsal from four pits from 5 to 30 cm.

Hispid cotton rat (*Sigmodon hispidus*) bones include 5 mandibles and a tibia from four pits between 5 and 35 cm.

The bones of raccoon (*Procyon lotor*) are a mandible, 2 teeth, humerus, ulna, and bacculum which were in four pits between the surface and 25 cm.

Bones that could be from either bison (*Bison bison*) or domestic cow (*Bos taurus*) were on the surface and as low as 30 cm. The bones are axis, 13 ribs, 2 leg bone fragments, a metapodial fragment, and a sawed round steak bone. The sawed bone was in the upper 5 cm. Bones of the white-tailed deer (*Odocoileus virginianus*) total 259 and were in all levels. The particular bones are maxilla (2), mandible (10), tooth (49), antler (4), petrous bone (3), axis, vertebra (15), scapula (2), humerus (16), radius (10), ulna (5), metacarpal (11), rib (28), innominate (4), femur (11), tibia (8), patella, metatarsal (11), metapodial condyle (4), pisiform (2), unciform (2), cuneiform (2), lunar (4), scaphoid (2), trapezoid magnum (5), centroquartal (3), malleolus (3), tarsal (3), astragalus (6), calcaneus (3), sesamoid (3), and phalanx (26).

Discussion

The occupants of the site were consuming fish, turtles, and deer at all times and were using walnuts, frogs, alligators, snakes, birds, and small mammals at least during the Late Prehistoric. The round steak bone indicates a late intrusion at the location. The large bovid may be modern cattle as well.

The high incidence of ends of deer long bones that were recovered could be due to any of several factors. The soils may be of such chemical nature that little bone was lost through decomposition. The cooking practices may not have included use of ends of bones or they may have had a surplus of deer meat. The people may not have had dogs to eat bone scrap. The site may have been more intensively occupied than other sites in the neighborhood. Bias in the surface collections may have skewed the totals.

The charred fragments of walnuts suggests that they were fractured for the nut meat and then tossed into a fire. The walnuts ripen in September and October (Vines 1960, p. 123). There is a large, old walnut tree at the edge of the site, so the walnut fragments may be historic.

Conclusions

The people who were at the site apparently always had heavy dependence on deer with steady use of turtles and fish. Other varieties of animals were added as they were available.

The only evidence of seasonality indicates that they were on the site at least during the fall season.

References cited

Patterson, L. W., and J. D. Hudgins
1989 Excavations at Site 41WH12, Wharton Co., Texas. Houston Archeological Society Journal 95

Vines, Robert A.
1960 Trees, Shrubs and Woody Vines of the Southwest. University of Texas Press, Austin

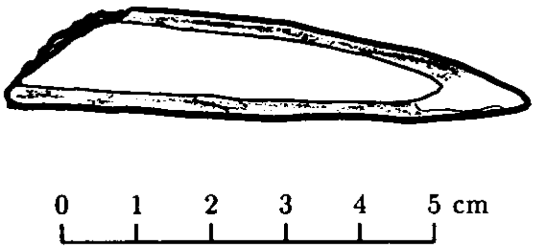

Figure 1. 41WH12 long bone tool

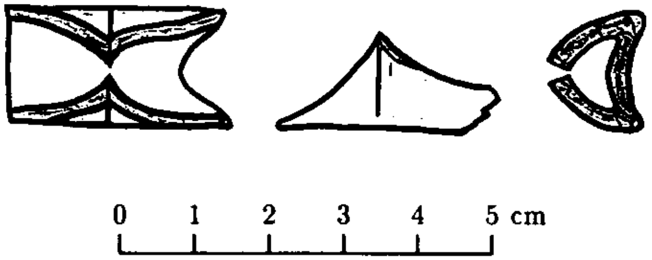

Figure 2. Metatarsal fragment — three views

Rangia Shellfish Utilization: Experimental Studies

L. W. Patterson, C. R. Ebersole, and S. M. Kindall

Introduction

The *Rangia cuneata* brackish water shellfish was utilized as a food resource in large quantities by prehistoric Indians of the upper Texas coastal margin. Large shell midden sites are well known (Aten 1983), and can have tons of Rangia shell. Some shell midden sites have been mined commercially in recent time. This paper describes the results of experimental studies with a sample of live Rangia specimens taken from northern Trinity Bay a few miles west of the Trinity River delta on the upper Texas coast.

Two types of studies were done using a sample of Rangia specimens that were collected alive in February 1992. After collection, experiments were first done to gain insight on how Indians processed large quantities of Rangia for use as food. Then, shell growth ring measurements were made on the specimens in the 1992 sample, to check the accuracy of Aten's (1981) seasonality correlation with the actual gathering time of this sample.

Reasons are presented here on why the application of heat would have been the best method for Indians to process large quantities of Rangia for meat extraction. It is also noted that there are problems with the accuracy of Aten's (1981) correlation for determining the seasonality of Rangia harvesting, and possible reasons for these problems are discussed.

Rangia sampling technique

The live Rangia sample was gathered by Ebersole and Kindall, operating out of a small skiff. The technique was to feel around the bay bottom in worn-out thin-soled shoes (an item easily found in archeologists' wardrobes), and when a lump was detected to squat down in the cold water to feel for shells, and then to dig them barehanded. Squatting in the cold water has a calming effect on whatever libido remains to the gatherers after a cold boat ride, but exposes them to ridicule and coarse remarks from passing fisherfolk in larger boats.

Rangia processing experiments

It is important to address the question of how Indians processed large quantities of Rangia for food use, to obtain a better interpretation of activities at coastal shell midden sites. A basic question is how did Indians open the Rangia shell to extract the meat. It was found from the sample of live Rangia studied here that there is a very tight seal at the seam of the two halves of a Rangia shell. It was very difficult to insert a thin knife blade into the seam of a Rangia shell, at 3 and 12 hours after gathering the sample. After 20 hours from the gathering time, it was only marginally easier to insert a thin knife blade into the seam of a Rangia shell.

As an additional experiment, the thin edge of a Rangia specimen was broken and a wedge-shaped bamboo tool was inserted into the opening at the shell break. Pushing this wedge-shaped tool directly into the shell was not effective in opening the shell. The bamboo tool broke when twisted. As a contrast, Rangia shells opened within two minutes in boiling water.

Prehistoric Indians would not have had tools that were effective for the mechanical opening of Rangia shells. It is concluded that some method of heat application would have been the most likely method of processing Rangia. At shell midden sites on the upper Texas coast, there is little evidence that Rangia shells were opened by simple breakage. Most shells in a typical shell midden site are in the form of unbroken shell halves.

Processing Rangia by the application of heat could have been by (1) boiling in ceramic pots, (2) steaming in pits with moist vegetable material over hot coals, as at a modern clambake, or (3) direct roasting on or near a fire. There is usually little evidence of direct roasting of Rangia at archeological sites, except that typically a small percentage of shell are burnt. Roasting could have been done at a short distance from a fire with little resulting burnt shell. Steaming of Rangia would have been a practical processing method, but little evidence for use of this method would have been preserved at archeological sites.

It seems likely that at least some Rangia were processed by boiling in ceramic pots. Large shell midden sites in this region commonly have large quantities of potsherds. One likely use for the large amount of pottery would have been for the processing of Rangia. Another major use for pottery at shell midden sites may have been for the storage of fresh water, since shell midden sites were at brackish water locations, where water salinity was too high for human consumption.

In the live Rangia sample discussed here, boiling was a very good processing method. Each Rangia specimen gave about 3 grams of cooked meat after 3 minutes of boiling. The cooked meat was easily removed from the shell, with no meat still clinging to the shell walls. The cooked Rangia meat is firm textured, and resembles saltwater clam meat that is commonly served in clam chowder. Richey Ebersole ate the meat of a raw Rangia specimen, and observed that the meat was fully palatable.

Seasonality determination

The Rangia sample under consideration here was taken from a location on the northern shore of Trinity Bay off the Trinity River delta, a few miles west of the mouth of the river, on February 23, 1992. Shell growth ring data from 60 right-hand Rangia shell halves were tabulated for use of Aten's (1981) seasonality correlation. A computer program by Carlson (1987) for Aten's correlation was used to make calculations to determine the month of Rangia gathering, with results shown in Figure 1. The calculated month of Rangia gathering from Aten's correlation is very different from the actual month that the sample was gathered. Live Rangia were collected in late February, but the calculation of seasonality with Aten's correlation gives a gathering time of mid-July.

Karen Gardner of Prewitt and Associates has independently made growth ring measurements on 57 left-hand Rangia shells from the same late-February live Rangia sample. Her results were 6 interrupted, 15 early, 28 middle, 8 late, and 0 indeterminate. These data give a late May seasonality determination using Carlson's computer program. Gardner's result is almost two months different from Patterson's result using right-hand shells, which shows that there can be some difference in measurements by individual analysts. Also, there may be differences in measurement results from right-hand and left-hand shell samples. However, the mid-May determination using Gardner's measurements is still a warm weather time that is considerably different from the actual live Rangia sample date of late February.

Aten's Rangia seasonality correlation uses data from live Rangia samples taken during a few years in the 1970s. An assumption was made that these data are generally applicable to Rangia samples from any year. This appears to be an incorrect assumption, since Rangia yearly shell growth ring patterns can be variable, due to variable environmental conditions. The late-February Rangia sample used for this paper comes from fairly extreme growing conditions of low water salinity and unusually high water temperature. The 1991-1992 winter season was unusually mild, and the salinity of Trinity Bay was lowered during this time period by a record flow of fresh water into the bay over an extended time period.

Another factor possibly affecting Rangia growth patterns is that individual locations may have differing Rangia growth patterns due to differing environmental conditions such as water salinity, available nutrients, and tidal flow. This is an additional consideration that should be made in judging whether or not Aten's seasonality correlation has general applicability.

Even if Aten's seasonality correlation were accurate on a single-month basis, this correlation would not be applicable to a scenario where Indians gathered Rangia during several scattered time periods during the year. In this case, any sample of Rangia shell from an archeological site could represent a mixture of shell gathered during different months. Aten's seasonality correlation only represents individual months, with no method to resolve questions of mixtures from different months.

Mixtures of shell from different months may explain why Aten's correlation most often gives determinations for archeological samples of summer months, such as June, July, and August. A number of combinations of Aten's (1981:Table 3) basic monthly data were found that yield determinations of summer months for Rangia gathering. An average of Aten's data for mid-April and mid-September gave a calculated answer of mid-August. Several averages of Aten's basic data gave a calculated answer of mid-July, including averages of data for March-June-October, March-May-July-September, and April-June-September.

Aten (1983:158, 1981:197) has concluded that coastal shell midden sites were occupied mainly during warm summer months. The above discussion does not support this conclusion. Coastal shell middens may have been occupied periodically during several months of the year, perhaps not even the same months every year. There are some other data that support the concept of some use of shell middens in other than summer months. At the J. D. Wells site (41HR639), fully developed deer antler attached to a skull indicates fall-winter site occupation (Patterson 1990a). A historical account by Cabeza de Vaca (Hedrick and Riley 1974:26) states that he went to a mainland coastal location, probably opposite Galveston Island, to exploit shellfish from December through March. Another consideration is that the coastal marshlands may have been more attractive for occupation by Indians during other than summer months, due to the absence of the myriad summer mosquitos and other pests, and because the coastal margin is warmer than inland areas in the cooler months. Also, waterfowl would have been an additional food resource for exploitation on the coastal margin mainly in other than summer months.

Patterson (1990b) has proposed a seasonal subsistence model based on the distribution of coastal margin pottery types, where Indians of the coastal margin of Southeast Texas utilized a band of land about 20 miles wide along the coast for much of the year, with some trips to locations farther inland on an infrequent basis. This model is compatible with occupations of coastal midden sites more than one time per year.

Summary

Results have been given on studies regarding processing of Rangia shellfish for food use. Experiments in opening fresh live Rangia specimens indicate that heat application, rather than a mechanical method, is the best way to process Rangia for meat extraction. Heat processing of Rangia could involve boiling, steaming, or roasting techniques.

Seasonality calculations for Rangia gathering time, using Aten's (1981) correlation for shell growth ring patterns, do not give good results compared to the actual gathering time of a live Rangia sample from Trinity Bay. Aten's seasonality correlation for Rangia may not be accurate because of variations in growth patterns from year to year caused by variability in environmental conditions, such as water salinity and temperature. Location of sample may also be important. The applicability of Aten's seasonality correlation for Rangia has been questioned on the basis that the correlation does not seem to be appropriate for periodic occupation of a shell midden at more than one time during a year. Additional research is needed to resolve issues regarding seasonal occupations of coastal shell midden sites. The pioneering nature of Aten's (1981) research should be recognized, however, as forming a starting point for ongoing investigations.

References cited

Aten, L. E.

1981 Determining Seasonality of *Rangia cuneata* from Gulf Coast Shell Middens. Bulletin of the Texas Archeological Society 52:179-200

1983 Indians of the Upper Texas Coast. Academic Press

Carlson, D. L.

1987 *Rangia Cuneata* as a Seasonal Indicator for Coastal Archeological Sites in Texas. Bulletin of the Texas Archeological Society 58:201-214

Hedrick, B. C., and C. L. Riley

1974 The Journey of the Vaca Party. University Museum Studies No. 2, Southern Illinois University

Patterson, L. W.

1990a Excavations at the J.D. Wells Site (41HR639), Harris Co., Texas. Houston Archeological Society Journal 97:1-7

1990b The Distribution of Coastal Margin Pottery Types in Southeast Texas. Houston Archeological Society Journal 97:14-19

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0.4016 Mid January   |********************
0.4467 Late January  |**********************
0.4261 Mid February  |*********************
0.3417 Late February |*****************
0.2632 Mid March     |*************
0.2150 Late March    |***********
0.1742 Mid April     |*********
0.1357 Late April    |*******
0.0924 Mid May       |*****
0.0582 Late May      |***
0.0494 Mid June      |**
0.0504 Late June     |***
0.0348 Mid July      |**
0.0563 Late July     |***
0.0919 Mid August    |*****
0.1120 Late August   |******
0.1199 Mid September |******
0.1320 Late September|*******
0.1629 Mid October   |********
0.1779 Late October  |*********
0.1771 Mid November  |*********
0.1869 Late November |*********
0.2350 Mid December  |************
0.3252 Late December |****************
                     +----+----+----+----+----+----+----+----+
                        0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80
                                      error probability


The best fit is Mid July.  The error sum of squares is 0.034756.
The mean squared error is 0.186108 with variance 0.014656.

                    Inter.   Early   Middle    Late    Indet.   Total

Rangia Counts:          11       8       22      12         7      60
Proportions:        0.1833  0.1333   0.3667  0.2000    0.1167
Expected:           0.0482  0.0827   0.3905  0.3156    0.1630

  Calculated month: July
  Actual sample month: February (2-23-92)
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Figure 1. Summary of seasonality calculations for a live Rangia sample