SHELLFISHING SEASONS IN THE PREHISTORIC SOUTHEASTERN UNITED STATES

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*Shellfish seasonality studies are summarized in this article, which presents the results of analysis at 94 sites in nine southeastern states. All but six of the sites are middens or shell lenses composed of marine or brackish water species (*M. mercenaria, R. cuneata, D. variabilis*). Shells in those sites along the Atlantic coast were collected from fall to early spring, while shells in sites on the Gulf coast were collected during early spring to summer. Freshwater shellfish middens in four states have been investigated and consistently indicated collection during warm weather. The uniformity of the results indicates that the variation in species used, techniques used, sample sizes, or geography have no noticeable negative impact on the usefulness of the results. It is argued that shellfish were a staple in the diet of many prehistoric horticultural peoples in spite of the fact that they are a dietary supplement for modern hunters and collectors.*

Techniques for estimating season of death of bivalve molluscs have been applied to archaeological materials since 1969. Although the methodology is considered experimental by some archaeologists, the technique is an old and established one in malacology and paleontology. Evolutionary, ecological, and biological studies of shellfish have relied on growth-line analysis since the first decade of the twentieth century. Management of shellfish populations first for the shell button industry and today for the seafood industry has likewise relied on growth-line data throughout this century (see for instance Coker et al. 1922; Isely 1914). Concurrent with the present commercial interest in marine shellfish, numerous geologists, biologists, and malacologists have experimentally demonstrated the annual occurrence of growth breaks in a large number of species (Barker 1964; Caddy and Billard 1976; Clark 1968, 1979; Craig and Hallam 1963; Davenport 1938; Gordon and Carriker 1978; House and Farrow 1968; Jones et al. 1978; Koike 1980; Mason 1957; Pannella and MacClintock 1968; Thompson 1975; Wilbur 1972). In those fields there are no longer challenges to the validity of the methodology, a point emphasized by the recent publication of numerous articles that build upon the temporal analysis of growth lines (see *Skeletal Growth of Aquatic Organisms*, Rhoads and Lutz 1980). Furthermore, several researchers in other disciplines who have performed this analysis on archaeological materials have substantiated their own season of death interpretations with oxygen-isotope analysis (George Clark and Doug Jones, personal communication 1984). A recent introductory text to the field of archaeology (Thomas 1979) has recognized that this type of analysis is far from experimental in the other disciplines that study the physical remains of the past. Finally, shellfish seasonality research programs like that underway by Debbie Mayer O'Brien for St. Catherine's Island sites clearly show the reliability of the method (O'Brien and Peter 1983).

Several reviews and critiques of the techniques now in use in archaeological studies have appeared (Claassen 1982; Ham and Irvine 1975; Monks 1981; Shaw 1978), but to date there has been no synthesis of substantive results largely because these projects represent an eclectic group of methods, sites, and geographical locales. There is, however, one prehistoric region, that of the southeastern United States, where reports are now numerous enough to warrant a summary of our knowledge. Both freshwater and saltwater sites occur in this region and they are discussed separately.

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American Antiquity, 51(1), 1986, pp. 21–37.

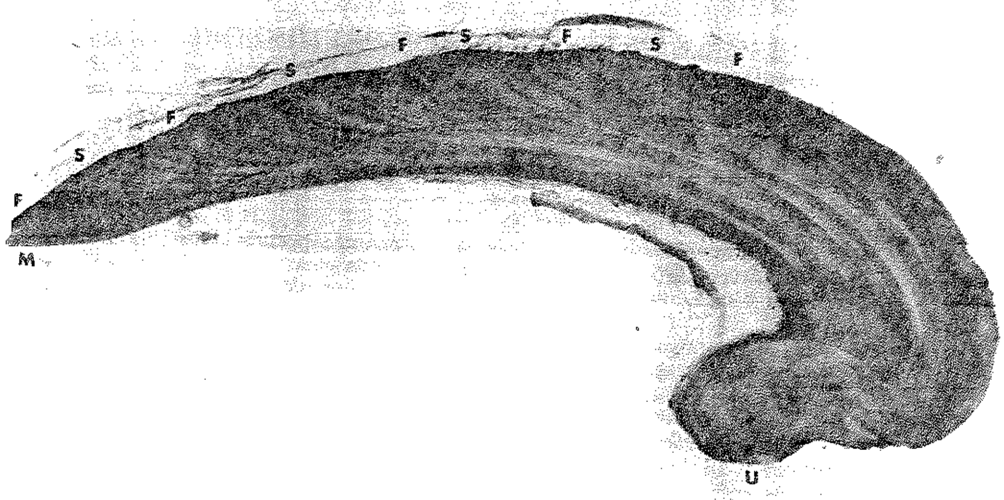

Figure 1. Internal growth in a bivalve shell. Fast growth is dark in color while slow growth is white.

FRESHWATER SHELL SITES

Collection of freshwater molluscs began as early as Paleoindian times as indicated by shells found at the Levi Site in Texas (Alexander 1963) and at Hell Gap in Wyoming (Irwin-Williams 1973), but it was not until the Middle Archaic Period in the Southeast that mounds of shell accumulated, first along the St. John's River in Florida (6000 B.P.) and later in the Shell Mound Archaic of the Midsouth. At the close of the Archaic, mounds of freshwater shells disappear from the archaeological record although shell lenses do occur in later sites in the Southeast.

Although freshwater shell middens exist in every southeastern state, very few investigators have attempted to estimate seasonality of archaeological freshwater bivalves. I have undertaken studies at two sites in southern Ohio, two sites in Kentucky, one site in Texas, and one in Georgia. The procedure is as follows. After cross sections of freshwater shells are prepared, macroscopic examination of the shell margin or hinge area permits separation of the sample into those specimens killed during fast growth (the margin consists of white shell) or slow growth (the margin consists of grey shell). (Fast and slow growth are visible in Figure 1.) Duplicate valves are eliminated by uniformly selecting only the left valve of the shell for analysis. (For the treatment that follows it is essential that the sample represent a single death assemblage, an argument generally based on the small size of proveniences used in column sampling.) Having separated the sample into two piles according to the shell coloration at the time of death, the percentage of fast growth specimens is calculated. This percentage is compared to percentages from collections of living specimens killed on a monthly basis. Figure 2 shows the fast–slow percentage data for *Lampsilis radiata luteola* (Fat Mucket) collected monthly during 1982–1983 from Laughery Creek, southern Indiana. As an example, if none of the specimens from an archaeological provenience had been killed during fast growth (0% fast growth), collection during the months of December and January would be indicated. This graph was used in interpreting the data from the Ohio, Kentucky, and Georgia sites to be described below.

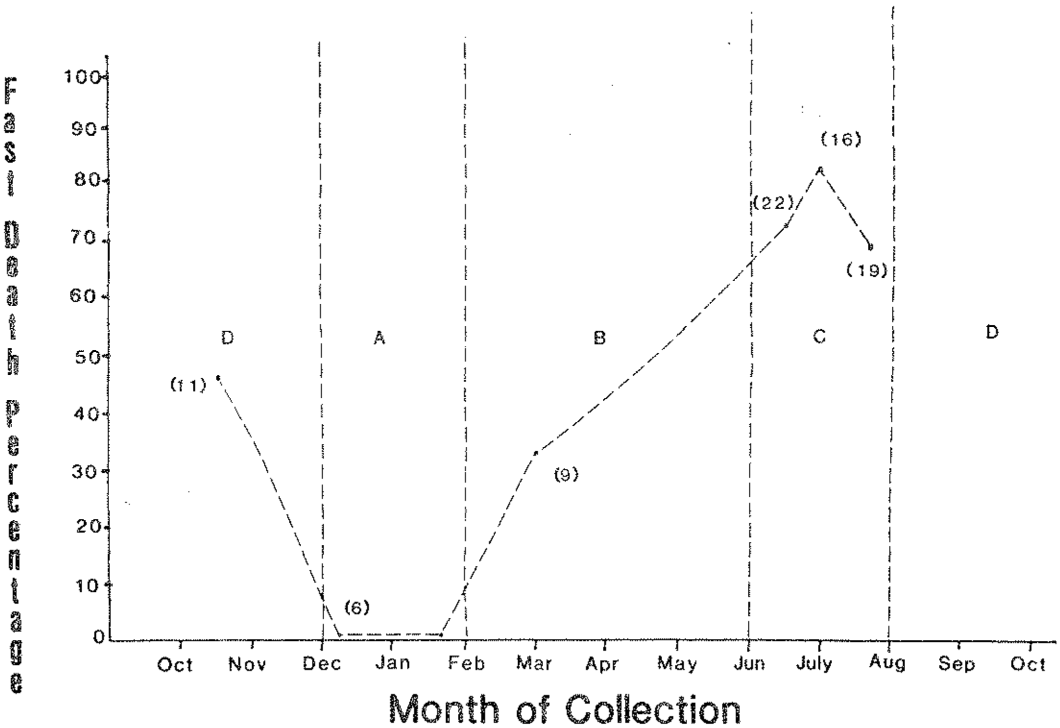

Figure 2. Growth graph of modern *Lampsilis radiata luteola* collected in 1982–1983 from Laughery Creek, Indiana. Numbers in parentheses indicate the sample size.

Results produced by this technique of sorting thick sections into either death during fast growth or death during slow growth are comparable with results generated when the amount of growth in the final year is correlated to a time interval for each individual shell, requiring thin sectioning (Debbie Mayer O'Brien, personal communication 1984). A major advantage to thick-section, fast–slow sorting, is the tremendous savings in time over thin section preparation and interpretation of individual shells.

Two points about the graph in Figure 2 should be noted. First, the graph represents only one year's collecting. As a consequence, variation in the monthly percentage of animals growing rapidly is unknown. Specific monthly assignments for prehistoric collections are to be avoided until variation over several years has been observed for each month. In applying these data to data from the past, it has been assumed that environmental differences (of particular importance are annual water temperature profiles) between a study period in the past and that of the present would introduce differences equivalent to no more than one month's growth. Second, *L. radiata luteola* is a long-term or bradytictic breeder. It is anticipated that a graph for a short-term or tachytictic breeder would be steeper and more constricted. Regardless of breeding group, water temperature regimes control the beginning and end of growth of all species populations. By using as a control a long-term breeder, the maximum fast growth period for short-term breeding species is also indicated. Warming water would trigger increased metabolic activity (fast growth) in all freshwater species in the United States so separate profiles for each species are unnecessary. My technique, described briefly here, is provided in greater detail elsewhere (Claassen 1982, 1983, 1984).

Ohio

The Dupont site (33Ha11) is a late Archaic Period site in Hamilton County, at the confluence of the Great Miami and Ohio rivers. It has been interpreted as a summer–fall site with light use in

Table 1. Seasonality of Bivalves from the Carlston Annis Site, Kentucky.

Sample	Sections Prepared	Sections Usable	Percent Fast Growth
1	20	7	86
2	13	6	83
3	15	9	78
4	28	11	82

late winter (Kent Vickery, personal communication 1983). Freshwater shellfish of 38 species were confined to the numerous pits and oven features at the site. Although 1,800 valves were in the collection, only 53 individuals (8 species) from nine features were usable for analysis—most of the specimens were in an advanced state of deterioration. In accordance with the seasonal interpretation already indicated, eight of the features appear to have been filled with shellfish killed during the June to August period and one feature with shellfish that died during February–March or November–December. The difficulty in collecting winter and spring monthly samples due to high water at those times suggests that the late fall is a more likely collecting time.

The Stateline site (33Ha58) is a Ft. Ancient phase Mississippian site also in Hamilton County, along the Ohio River. Occupation is thought to have been year round (Kent Vickery, personal communication 1983). Like the earlier DuPont site, this is not a shell midden; shellfish remains are confined to features. Considerably less shell was recovered at the Stateline site. Eighty-one shells of 12 species were sectioned, of which 51 (63%) were usable from seven features. While the site was inhabited year round, shellfish were collected seasonally sometime during the June to August interval.

Kentucky

The Carlston Annis (15Bt5) and DeWeese (15Bt6) shell mounds in the Big Bend region of the Green River are Archaic sites recently tested by the Shell Mound Archaeological Project (Marquardt and Watson 1983). A study of four, vertically placed, non-contiguous samples from one wall of excavation unit 55N55E at the site involved 76 thin sections. Table 1 summarizes the shellfish seasonality data. This analysis indicates death during the June–August period based on the modern temporal control from southern Indiana (Figure 2).

At the DeWeese Mound, shell for analysis was taken from a 268-cm-deep column (taken from the center of the mound) approximately 20 cm^2 and divided into samples 5 or 6 cm thick. This column contained 5,816 bivalves of 29 species, 1,550 of which were cut for analysis; 1,162 were usable (75%) of nine species. Table 2 presents the results of the study. Without knowledge of variation in monthly figures over several years, it is possible at this time to say only that shellfishing occurred sometime during the months of February to December. Because the lowest fast growth percentage is 36%, a more realistic estimate is March to November based on Figure 2. High water levels during winter and spring months suggest an even smaller temporal range of summer–fall collecting. The possibility that discrete collecting years are indicated in this series of samples has been explored (Claassen 1984).

Texas

Freshwater shell lenses are commonly found in Archaic sites like 41Ft180 on the Trinity River, which contained five species of bivalves. The extremely small sample of 11 shells from one level of a 1 m^2 unit indicated a June to August death based on the growth observations of Isely (1914) for Oklahoma shellfish.

Table 2. Seasonality of Bivalves in a Column Sample from Deweese Site, Kentucky.

Depth (cm)	Fast (%)	Slow (%)	No. of shells	Season
50–55	0	0	0	—
55–61	63	37	24	B or D
61–67	79	21	14	C
67–73	63	37	16	B or D
73–78	77	23	13	C
78–83	0	0	0	—
83–89	79	21	14	C
89–94	67	33	9	B or D
94–100	70	30	10	C
100–105	48	52	31	B or D
105–110	44	56	25	B or D
110–115	79	21	28	C
115–120	78	22	18	C
120–126	60	40	30	B or D
126–132	55	45	40	B or D
132–138	68	32	50	B or D
138–144	57	43	46	B or D
144–150	50	50	32	B or D
150–156	0	0	0	—
156–162	40	60	15	B or D
162–169	40	60	15	B or D
169–175	36	64	11	B or D
175–180	63	37	30	D or B
180–185	50	50	30	D or B
185–190	53	47	15	D or B
190–195	67	33	27	D or B
195–200	63	37	24	D or B
200–205	65	35	26	D or B
205–210	79	21	28	C
210–215	58	42	79	B or D
215–220	41	59	41	B or D
220–225	63	37	84	B or D
225–230	56	44	57	B or D
230–235	69	31	65	B or D
235–240	55	45	49	B or D
240–245	38	62	55	B or D
245–252	79	21	14	C
252–257	73	27	26	C
257–262	53	47	36	B or D
262–268	71	29	35	C
40 provenıences			1,162	

[a] A, December to February; B, February to June; C, June to August; and D, August to December.

Georgia

Shellfishing in the Late Woodland occupation at the Ruckers Bottom site (9Eb91) on the Savannah River was examined in three samples of shells. Although 120 shells were in the sample from feature A13, only 50 were usable. The 26 right valves were cut, of which 15 were readable. Eighty percent died during fast growth characteristic of summer collections in southern Indiana. Given the longer warm season in Georgia, the results were taken to be representative of June–September. Samples A18 (N = 16) and A25 (N = 22) returned proportions of 56% fast, and 45% fast, respectively. Only winter and summer quarters of the year for collection can be ruled out by these percentages. There

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is then evidence for either spring–summer or summer–fall occupation (Blanchard and Claassen 1985).

SALTWATER SHELL SITES

Marine shell mounds comparable in size to those of the Shell Mound Archaic post-date the formation of oyster beds. Oyster beds apparently began forming as sea level stabilized: in Florida at 2500 B.P. (Milanich and Fairbanks 1980:146–155) and 2300 B.P. in North Carolina (Claassen 1982:260). *M. mercenaria, D. variabilis,* and razor clams, as well as some oysters were collected in small numbers prior to this time (Claassen 1982:261).

Unlike the situation with freshwater bivalves, there are numerous people working on the question of shellfish seasonality at coastal sites and a plethora of techniques is in use. Seasonality assessments have been made for 21 sites in North Carolina, 8 sites in South Carolina, 31 sites in Georgia, 4 sites in Florida, and 24 sites in Texas. Three species have received attention: *Rangia cuneata, Mercenaria mercenaria,* and *Donax variabilis.* Conspicuous for its absence from this list is the eastern oyster. According to several geological pioneers in molluscan incremental growth studies (i.e., George Clark, personal communication 1981; Lutz 1976) oyster growth lines cannot be reliably equated to annual increments of time. For this reason several seasonality studies that have relied on oyster are omitted from this presentation. Research by geologist David Lawrence presented at the 1984 SEAC conference does seem to have identified a seasonality method for oyster however.

North Carolina

In a single study by the author (Claassen 1982, 1983), 19 Woodland period (3000–400 B.P.) shell middens from the coast of Onslow County, North Carolina, were column sampled. These sites contain two species, *M. mercenaria* and *Crassostrea virginica,* in various percentages and are typically no more than 40 cm deep. The density of shell suggested that some of these columns were from shellfish processing stations (high density) and some were from habitation areas (low density). In all, 785 shells from 96 proveniences (25 × 25 × 5 cm) in 19 sites yielded information on their time of death. The analytical procedure used is the same as that previously described for freshwater shells (see also Claassen 1983).

Modern *Mercenaria* were collected at bimonthly intervals from coastal North Carolina during 1979–1980, and these were sectioned by Dr. George Clark, Geology department, Kansas State University. The percentage of animals dying during fast growth each month is graphed in Figure 3. *M. mercenaria* is a very long-lived species often found with dozens of annuli crowded into the last centimeter of shell. The first 6–8 years of life are known as the juvenile and mature growth stages each year seeing the addition of relatively large amounts of shell. These annual increments of growth are visible macroscopically and present the researcher with little ambiguity. For this reason, many researchers rely exclusively on juvenile and mature specimens in their analysis. Figure 3 depicts fast-growth percentages for collections of juvenile and mature specimens. This temporal control has similarly been applied to archaeological collections of juvenile and mature specimens from the North and South Carolina sites described below.

A second point to be raised about Figure 3 is that during any month of the year in North Carolina animals can be found in slow growth. In fact, the growth rate is increasingly less uniform in Atlantic waters as one moves north from Florida. Some shellfish seasonality analysts equate a specific month with slow growth, an assumption of uniform growth rate in the study population. In some latitudes this assumption is permissible (e.g., Georgia), but in most it is not.

For all but five archaeological proveniences in the Onslow County study, the collection time fell between November and June. The actual percentages obtained, 100% to 50%, suggest November to April. The five exceptions are summer collections, four of which are from surface layers. Historical notes record a summertime shellfishing season in North Carolina and apparently record a change in aboriginal scheduling stimulated by trading opportunities with European ships which customarily arrived in the summer months. The four surface-layer summer shellfish collections may then have

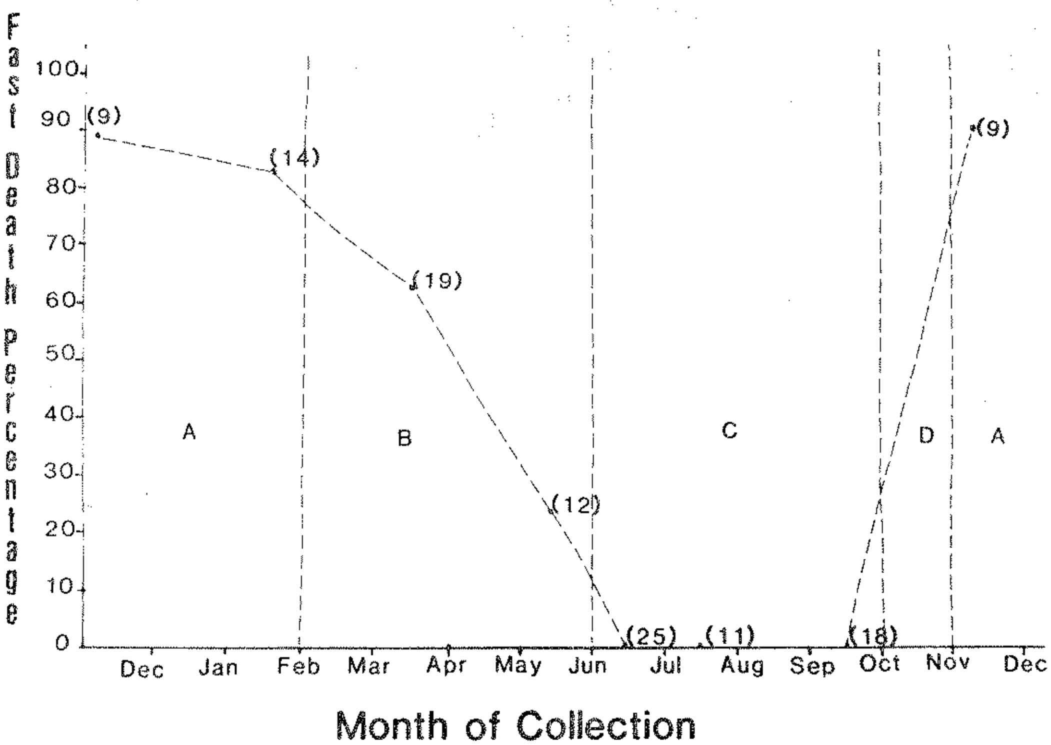

Figure 3. Growth graph of modern *Mercenaria mercenaria* collected in 1981 from Onslow Bay, North Carolina. Numbers in parentheses indicate the sample size.

accumulated during the protohistoric or historic period. The remaining exception is the initial shell layer at a Middle Woodland site, to be discussed later.

The Jordan Permit site, 31NH256, and the Stoney Brook midden, 31NH556, are Middle Woodland Period marine shell middens in New Hanover County. Both sites were very shallow (14 cm and 20 cm), were column sampled (Mark Wilde-Ramsing, personal communication 1983) and indicated the November to April collection period. Sample sizes were 120 and 157 *Mercenaria* shells, respectively.

South Carolina

In North Carolina sites *Mercenaria* is abundant in many middens, but this species is extremely rare in South Carolina coastal middens prior to the Late Woodland Period. Sites from which shells have been examined are briefly described below. Unless otherwise indicated, the author performed the analysis on *M. mercenaria,* in each case relying on the modern growth data from North Carolina for the seasonal interpretation (Figure 3). Table 3 summarizes the shellfish seasonality data from South Carolina.

The sample sizes underscore the rarity of *M. mercenaria* in South Carolina middens. In each analysis I performed, all usable shell was thick-sectioned. The large sample from Winyah Bay is reflective of the large numbers of quahog that do occur in Late Woodland Period sites in Winyah Bay (Mark Brooks, personal communication 1983) and reportedly, in Pee Dee phase sites in Bulls Bay as well (Michael Trinkley, personal communication 1983).

The analysis of the two largest samples, those from Pinckney Island and Winyah Bay, indicate shellfishing in the fall and winter months; or more specifically the November to April period. Analysis of the smaller samples listed in Table 3, while too small to merit discussion, do concur with one exception, that based on an examination of three shells from the Deptford level at SoC 534. Only one shell died during fast growth (33%) indicating either May–June or October–November.

Georgia

Here, as in South Carolina, *Mercenaria* is a rare midden component. Clark (1979:166) has examined two specimens from burials in the McLeod Mound that suggested a December or January death to him as did five specimens from Feature 15 at the Seaside I site, 82% of the clams from Johns Mound and 69% of the clams from Marys Mound (Larsen and Thomas 1982:338). All sites are on St. Catherine's Island. To interpret the archaeological shell, Clark collected living quahogs from the local estuaries and identified several shell growth features specific to different phases of annual growth visible in thin-section.

Since Clark's work on St. Catherine's Island, 113 additional sites are known to contain small numbers of *Mercenaria*. The shellfish seasonality project currently underway by the American Museum of Natural History has continued the collection of a modern control sample, ascertained that present environmental conditions correspond to those of the study period through oxygen isotope analysis, and begun interpreting thin-sections of *M. mercenaria*. Sample sizes of 1 to 25 shells have been randomly selected for seasonality analysis from numerous proveniences in 24 sites to date. O'Brien and Peter (1983) report that 25% of the shells studied indicate collection during the fall, 52% in winter, and 16% in spring. Only 1% of the clams were collected in the summer.

The Mississippi Kenan Field Site has yielded *M. mercenaria* in sufficient numbers to determine fall–winter collecting. Shell samples ranging in number from 11 to 90 ($\bar{x} = 30$) from seven units in midden and six features (N = 551 shells) were examined surficially (Crook 1978:234–244).

Irv Quitmyer has thin sectioned shells from two sites in Kings Bay. The Devil's Walking Stick site (9CAM177) is a multicomponent site with Savannah and Protohistoric levels. One hundred twenty-one *Mercenaria* specimens were sectioned from the Savannah component. While all seasons were present, late fall was most heavily represented. From the Swift Creek phase (Middle Woodland) at 9CAM171, Quitmyer cut 40 specimens of quahog, which represented all seasons (Irv Quitmyer, personal communication 1983).

Shells from the Archaic Period St. Simons Island Shell Ring (excavated by Rochelle Marrinon) have also been examined. The 40 specimens thin sectioned by Quitmyer indicated a winter–spring collecting period.

Florida

The Fletcher site, 8SJ57, is a small St. Johns IIa (A.D. 863) coquina midden on the Atlantic Ocean whose shell zone is 7 cm to 15 cm thick (Miller 1980). Coquina spawn in March and live 17 months. Growing at a uniform rate as they do, shell length can be used to determine time of death (Figure 4). Miller used 500 coquina (*Donax variabilis*) valves from one provenience for a seasonality estimate and concluded that the sample represented an October collection. Examination of Miller's graph (Figure 4), however, suggests death sometime during the period October to January.

Miller also examined 500 coquina from the Palm Coast site on the Atlantic. As at the Fletcher site, fall shellfishing activity was evident (James Miller, personal communication 1983).

Rangia cuneata is the dominant shellfish species in middens in estuarine settings from Perdido Bay to Appalachicola Bay. The customary seasonality method proposed by Aten (1981) for *R. cuneata* presented several problems in application, encouraging the author to investigate alternative methods. One such alternative method has been applied to large samples of shell from Deptford and Mississippian components of two sites in Escambia Bay: 8SR85 and 8SR143.

Fairbanks (1963:20–27) reports finding several size classes of *R. cuneata* only during particular months of the year. Most of these, listed in Table 4, are valve sizes rarely encountered in archaeological samples, but individuals measuring 14.25 mm to 30.75 mm were plentiful in the Escambia Bay sites. Modern collections of this species in Escambia Bay during the period March through November 1984 also support the findings of Fairbanks.

From the single component Mississippian habitation site 8SR143, the measurement of 3,037

Table 3. Seasonality of Bivalves from South Carolina Sites.

Site	Location	Time	No. of Shells Used
Fish Haul Creek	Hilton Head Island	Stallings	4[a]
SoC 534	Charleston Ct.	Deptford	3[b]
		McClellandville	4[b]
SoC 533	Charleston Ct.	Middle Woodland	10[b]
Pinckney Island	Pinckney Island	Middle Woodland	33[c]
38GE238	Winyah Bay	Late Woodland	171[d]
Victoria Bluff	Beaufort Ct.	St. Catherines	3[c]
SoC 535	Charleston Ct.	Pee Dee	9[b]
Lodge Alley	Charleston Ct.	mid-1700s	9[e]

[a] Trinkley and Zierden (1983).
[b] Michael Trinkley (personal communication 1983, site data).
[c] Trinkley (1981); George Clark performed analysis.
[d] Mark Brooks (personal communication 1983, site data).
[e] Zierden et al. (1983).

shells indicated late summer, fall collections in 23 proveniences (30 × 30 × 5 cm), and summer collecting in four proveniences. (A determination on the basis of size was inconclusive in 20 proveniences.) The measurement of 1,783 shells from the Deptford component at 8SR85 indicated summer collecting in four proveniences and late summer, fall collecting in 12 proveniences (30 × 30 × 10 cm). The 25 Mississippian proveniences at the site were uniformly late summer, fall collections (3,849 shells were measured) (Claassen 1985).

Texas

All of the seasonality projects on marine shell in Texas have used the brackish water clam *Rangia cuneata.* Analysis of *Rangia* relies on surface indications of annual growth rather than internal examination. Modern control collections made by Aten (1981) have been the interpretive standard for these numerous studies. In a recent paper, David Carlson (1983) reanalyzed the available material including the control samples. Table 4 presents the data for each of 22 sites ranging from Chambers County on the upper Texas coast to Calhoun County on the central Texas coast. To this list should be added 41HR85 (Aten 1981) with a May estimate and 41CH46 with a late April estimate (David Carlson, personal communication 1983). The sample sizes for each site range from 20 valves to 500 valves.

All estimates for all sites fall within the mid-April through late July period. Both Skelton (1978: 271) and Carlson (1983:21) conclude that the collecting season was primarly during the months of April and May. Skelton (1978:272) further noted that "Portions of estuaries most affected by freshwater were particularly favored during the spring months while the open bays seem to have been frequented most during the warmer summer months."

SHELLFISH, THE SEASONAL FOOD

The time periods covered in this summary span the Late Archaic through historic times. Four Late Archaic freshwater sites, one Woodland site, and one Mississippian site have been studied to date. Marine sites include 1 Late Archaic component, 6 Early Woodland, 14 Middle Woodland, and 10 Late Woodland components, 3 Mississippian, and 1 historic site. The cultural/temporal affiliations for 26 St. Catherine's Island sites are unknown. The 24 Texas sites represent all time periods after Middle Archaic (Table 5).

In spite of methodological differences, disparate geographical locales, disparate cultures, and the use of numerous different species and sample sizes, the results of southeastern shellfish seasonality studies are in remarkable agreement. Regardless of the time period or the level of cultural devel-

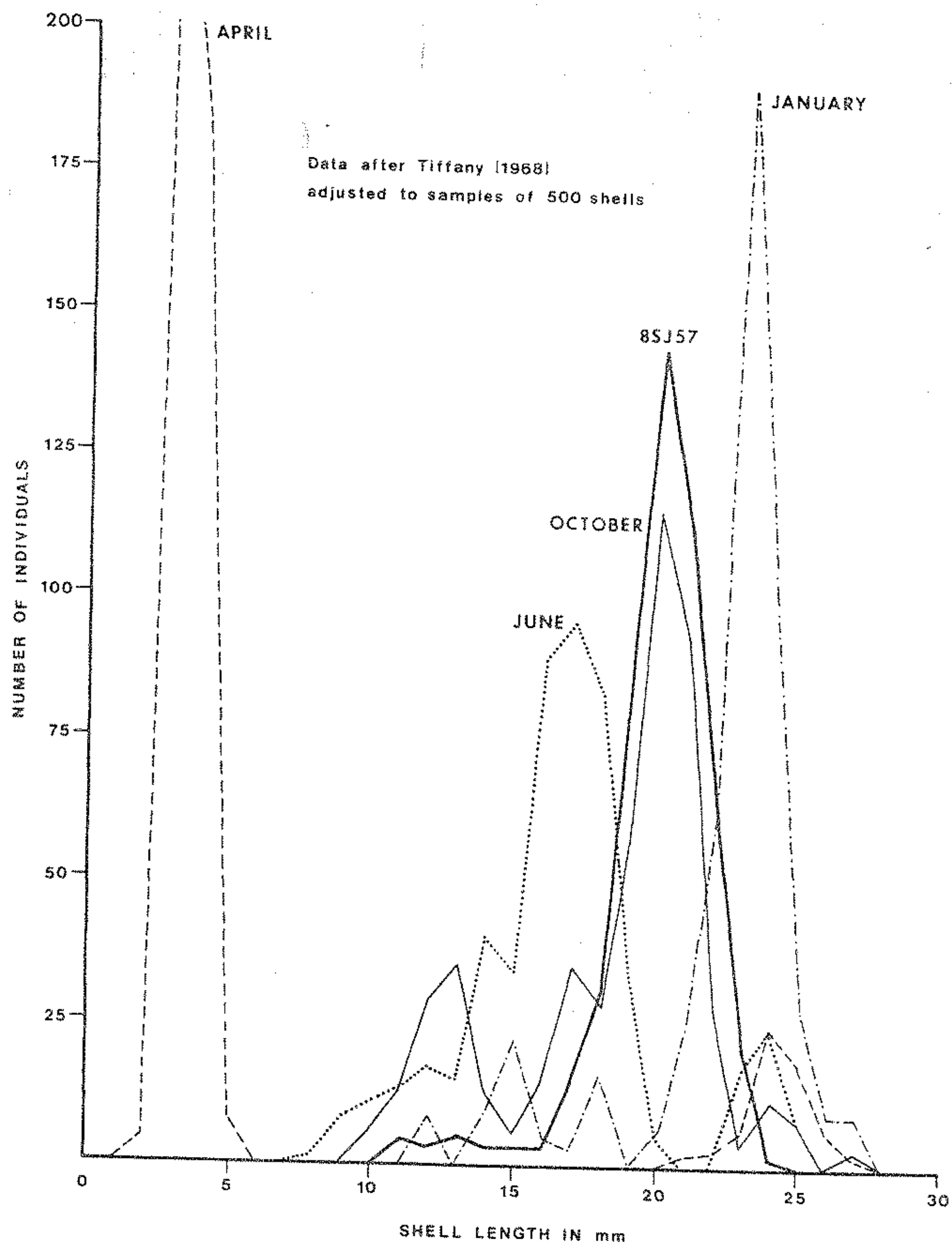

Figure 4. Growth graph of modern *Donax variabilis* collected from Alligator Harbor, Florida. (Taken from Miller 1980.)

opment in the southeastern United States, freshwater shellfish were collected spring to fall, with no indication of winter collecting. Brackish-water, Gulf-coast shellfish were collected spring to fall and Atlantic marine shellfish were collected principally late fall to spring. Minor amounts of summer collecting did occur in Georgia. Commercial shellfishing today in southern Atlantic water is also largely a fall–winter activity.

The exceptions are few. An initial layer of a column from a Middle Woodland component at

Table 4. Size Classes and Seasonality in *R. cuneata*.[1]

Size Class	Presence Period	Comments
0–1.75 mm	Winter	
0.25–0.75 mm		Highest densities of this class in March
0.375 mm	January, February	Most abundant size class
1.50–1.75 mm	Winter	High densities occur in January, April, May
1.75–22.75 mm	Summer	
6.75–7.75 mm		Largest class in September
14.25–23.75 mm	Summer only	4% of September 15 collection
26.75–30.75 mm	Late summer, fall	Found by Claassen in September and November 1984 in Escambia Bay, Florida

Mean length of population shows decline in late spring, early summer as young individuals are recruited.

[1] Taken from Fairbanks (1963:20–27).

310n21 (North Carolina) and the Deptford level at SoC 534 (South Carolina) contained shells apparently collected during the summer. In both cases fewer than six shells were usable in the analysis suggesting statistical errors. Four North Carolina sites had terminal layers that contained summer shells. These exceptions seem to indicate a change in shellfishing activities to correspond with the arrival of European ships.

Based on the results of these shellfish seasonality studies generated by 12 different researchers, I suggest that the majority of human shellfish collecting occurs during the period of the animal's fast growth. *Mercenaria,* for instance, experiences fast growth, or conditions most favorable for growth, from November through April in southern Atlantic waters. North of North Carolina, the summer months are most conducive to growth in this species. My research has indicated that while the shellfishing season in a particular watershed may span, for instance, November to April, actual collecting time in any one year may be considerably less than six months.

The conclusion of seasonal collecting and the seasons specified for the various locations have been foreshadowed by several seasonal round models. According to Jenkins (1974:186–187), macrobands in the Middle Tennessee Valley in late Archaic times were resident on the shell mounds May through October. As winter approached, high water from increased rainfall hampered the procurement of molluscs so that the groups splintered into microbands and moved upland for the winter. Walthall (1980:69) similarly concludes that Lauderdale phase residence on the shell middens was in late spring and summer months by families living in microbands. Smith (1975) concluded that Middle Mississippian populations fished and gathered turtles from April into September, the same time a Mississippian population is gathering shellfish in southern Ohio as reported here.

While supporting some interior seasonal round models, these findings challenge others. Winters (1969) reports that shellfish were abundant in Riverton Culture sites. The assigned season of occupation at Riverton (summer) and Swan Lake (fall, spring) does not contradict the finding of warm-weather, freshwater shellfishing. Robeson Hills, however, has been interpreted as a winter village. Although the number of studies are few, the results presented here suggest that the shellfish at Robeson Hills were collected during the late spring to early fall period and that occupation at the site was not during the winter exclusively as Winters claims.

The seasonal settlement pattern specified for occupation of St. Johns culture marine middens (Milanich and Fairbanks 1980:158) is winter, a conclusion in keeping with the marine shellfish seasonality presented by Miller and found to the north as well. The data from the marine middens in south-central North Carolina contradict the observations of several contact period and historical writers (summarized in Loftfield 1976). This discrepancy apparently reflects a resource scheduling

Table 5. Seasonality Determinations for Published *Rangia* Samples.

Site	Zone/Level	Estimate	Date	Reference
41CH32	1	Late April	A.D. 1500?	b
	2	Late May	A.D. 1400	b
	3	Poor fit	A.D. 1000–1400	b
	4	Late May	A.D. 500–1000	b
	5	Poor fit	A.D. 100–500	b
41CH47	1	Late April	A.D. 800?	b
	2	Mid-May	A.D. 700?	b
	3	Late May	A.D. 400–600?	b
	4	Poor fit	A.D. 100–500	b
	5	Late May	Late Archaic	b
41CH110	1	Late July	A.D. 1160–1760	a
		Mid-July	A.D. 1160–1760	a
	3	Mid-May	A.D. 1160–1760	a
		Late July	A.D. 1160–1760	a
	4	Mid-May	A.D. 1160–1760	a
		Late May	A.D. 1160–1760	a
		Mid-July	A.D. 1160–1760	a
		3-Poor fit	A.D. 1160–1760	a
41CH172	1	Late April	A.D. 100–500	b
	2	Mid-May	A.D. 100–500	b
	3	Mid-May	A.D. 100–500	b
	4	Poor fit	Archaic	b
	5	Poor fit	Archaic	b
	6	Mid-July	Archaic	b
	7	Mid-June	Archaic	b
	8	Mid-July	Archaic	b
41MG19	Surface	Mid-May	Late Prehistoric	c
41MG25	Surface	Mid-May	?	c
41MG29	Surface	Late May	?	c
41JK7	0–.5′	Mid-May	Late Prehistoric	c
		Late April	Late Prehistoric	c
		Poor Fit	Late Prehistoric	c
		Late April	Late Prehistoric	c
	.5–1′	Mid-April	Late Prehistoric	c
		Late April	Late Prehistoric	c
41JK41	Test	Late April	Late Prehistoric	c
41JK91	Upper cluster	Poor fit	Late Prehistoric	c
		Poor fit	Late Prehistoric	c
		Late April	Late Prehistoric	c
	Middle cluster	Poor fit	Archaic/Late Prehistoric	c
		Late April	Archaic/Late Prehistoric	c
	Lower cluster	Late April	Archaic	c
		Late April	Archaic	c
41JK110	Surface	Mid-May	?	c
41JK113	Surface	Mid-May	?	c
41JK114	Surface	Late April	Late Prehistoric	c
	Surface	Mid-July	Late Prehistoric	c
41JK118	Surface	Late June	Late Prehistoric	c
41JK120	Surface	Late May	?	c
41JK125	Surface	Late May	Late Prehistoric	c
	Surface	Mid-May	Late Prehistoric	c
41JK128	Surface	Mid-May	Late Prehistoric	c
41JK129	Surface	Late June	Late Prehistoric	c

Table 5. Continued.

Site	Zone/Level	Estimate	Date	Reference
41JK147	Test	Late April	Late Prehistoric	c
41CL35	Surface	Mid-July	?	c
41CL37	Surface	Late June	Archaic	c
	Surface	Mid-July	Archaic	c

Note: Table taken from David Carlson (1983).
[a] Dillehay 1974.
[b] Dillehay 1975.
[c] Skelton 1978.

change under the impetus of European coastal traffic, an argument further developed in Claassen (1982, 1983).

It is particularly interesting that only seasonal collecting is shown by these studies because accounts of modern shellfishers (Claassen 1982:165–166; Kirch and Dye 1979; Meehan 1977a, 1977b; Voigt 1975) show that they collect year round. All of these groups, however, are hunters and collectors while many of the coastal groups in the southeastern United States were horticulturalists at the time of contact. Are the modern shellfishers living in such marginal habitats that the dietary contribution of shellfish is necessary year round? Given the low percentage of kilocalories contributed by collected shellfish (see particularly Meehan 1977a) this is apparently not the case. Or is there a fundamental difference in the role shellfish play in the diets of hunters and collectors versus that for horticulturalists? Most of the data from cultural settings on the dietary significance of shellfish—that this is a supplemental foodstuff—come from these modern populations of non-horticulturalists. In those settings shellfish play a minor role (6–17% of total dietary calories) in the diet but are significant when other protein sources are not available, when fresh protein is desired, or when more food is needed at a meal. For example, molluscan meat contributed 24% of the total caloric intake in the pre-agricultural Mount Taylor period diet of St. Johns River, Florida (Cumbaa 1976).

As suggested, four archaeological faunal studies indicate that shellfish may be more important in the diets of horticulturalists than in those of hunters and collectors. Raymond (1981:809), who argues that Andean civilization was based on domesticated root crops, calculated that shellfish comprised 42% of the calories, the single most important source in the meat diet of preceramic peoples in the Ancon-Chillon valley of Peru. Midden analysis at a horticultural St. Johns II (St. Johns River, Florida) coquina midden indicates that coquina provided more than 50% of the total calories derived from meat (Miller 1981). A study in sites of Kings Bay, Georgia, estimated that 70% of the meat weight was derived from oyster (Quitmyer 1983). From the Georgia site of Pine Harbor, in the domain of the historic horticultural Guale, Larson (1980:226) reports that the bulk of winter protein came from oysters, deer being supplemental to the diet. These high figures represent a significantly different attitude toward shellfish on the part of horticulturalists than has been recorded among living hunters and collectors and some malacologists. "... It is submitted that even when valves occur in considerable numbers, such as at many of the Archaic period shell middens in the Southeast, the animal represented a resource exploited as a supplement, rather than a staple" (Parmalee and Klippel 1974:432). I submit that figures of 42%, 50%, and 70% represent more than a dietary supplement. While some researchers may feel the question of dietary significance has been adequately addressed, I would like to see a detailed discussion of the dietary role of shellfish in the range of subsistence strategies. The preliminary indication is that for hunters and collectors shellfish vary from a year round supplement (modern and Mt. Taylor Period examples) to a seasonal staple (i.e., the Shell Mound Archaic sites), and was a seasonal staple for coastal horticulturalists (preceramic Peru, St. Johns II period, Late Woodland Georgia).

Although the dietary analyses of shellfish just discussed clearly indicate the importance of this foodstuff as a source of protein (as does the discussion of molluscs by Wing and Brown 1979:139–140), the numerous interpretations of collecting during fast growth are indicative of perhaps an even greater use of this foodstuff for its carbohydrate content. Quantities of both protein and carbohydrates in shellfish fluctuate during the year. From December to May, the period of fast growth in the southern Atlantic, the quantity of carbohydrates in the oyster are highest. Conversely, the protein content is highest in the oyster from June to October, the period of slow growth (Galtsoff 1964: 382). If clams duplicate this seasonal difference in levels of protein and carbohydrates and if oysters and clams were both collected in winter, during fast growth, as work by David Lawrence indicates in South Carolina middens, prehistoric peoples were deriving the maximum amount of carbohydrates and the minimum in protein available from these animals. Failure to account for the seasonal fluctuations in levels of minerals, calories, carbohydrates, and protein in shellfish could be adversely affecting compositional analysis of shellfish and their extrapolated dietary importance. (See particularly Parmalee and Klippel 1974:Table 4, who do not specify the collection time of the assayed specimens.)

Although the question of seasonal versus year-round shellfishing has been settled in many parts of the southeastern United States, more work is needed to substantiate and extend geographically the results presented here and address the questions raised. Is there indeed a change in the subsistence scheduling with European contact? During what season(s) of the year did the English and Spanish settlers or the African slave population collect shellfish? What time of the year were freshwater shellfish collected in Atlantic coastal states?

Questions of temporal precision demand our attention in future research. Annual growth profiles with at least five years of data are needed for numerous latitudes to indicate monthly variation. Interpretations of prehistoric collecting during specific months should be possible with most species. Work with living *Rangia* has made possible temporal assignments to specific two-week intervals, but the identification of distinct seasons or microstratigraphy within a shell midden has received very little attention. Two methods of occupational stratification currently being developed offer great promise (Claassen 1982, 1983, 1984; Koike 1980, 1982).

The technical differences in estimating seasonality have failed to produce significant contradictory results among these 12 researchers, suggesting that the techniques are comparable in application and vary only in their precision. Rather than regarding this technique as experimental, we can proceed to use it with some confidence in answering the questions raised here and in determining the seasonality of shellfishing in other regions.

Acknowledgments. Much of the author's research presented here was performed while Charles Phelps Taft Postdoctoral Fellow in the Anthropology Department of the University of Cincinnati. I am grateful to Kent Vickery for his assistance in identification and collection of freshwater shellfish, to David Carlson for Table 4, James Miller for Figure 4, and to the following people for their unpublished site data and shell samples: Kent Vickery, Ohio; Patty Jo Watson, William Marquardt and the Shell Mound Archaeological Project, Kentucky; Tom Guderjan, Texas; Mark Ramsing, North Carolina; Michael Trinkley and Mark Brooks, South Carolina; David Anderson, Georgia; Judy Bense, Florida.

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