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Applying a Measure for Determining Season of Oyster Harvesting: A Case Study of a Pre-Columbian Florida Site, USA

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ABSTRACT: Over the past two decades, several methods have been developed for determining seasonal patterns of shellfish collecting in archaeological faunal assemblages. One such technique involves the use of the impressed odostome (*Boonea impressa*), a gastropod that is an ectoparasite of oysters and often found in archaeological oyster middens when fine recovery methods (1.6 mm screen or smaller) are employed. Shell length measurements of archaeological odostomes are correlated with modern studies on the snail's annual growth cycle, ultimately indicating season(s) of oyster harvesting by the site inhabitants. This technique is applied to the archaeological faunal assemblage at Greenfield Site No. 5 (8DU5541), a pre-Columbian site located along the Atlantic coast in northeast Florida, U.S.A. Over 6,000 odostomes were recovered in the 1.6 mm mesh screens. Shell length measurements indicate that oysters were harvested in the summer through late autumn months (July-November).

KEYWORDS: OYSTERS, ODOSTOMES (*Boonea impressa*), SEASONALITY, MIDDENS, FLORIDA

RESUMEN: Durante las dos últimas décadas, se han implementado una serie de métodos para determinar los patrones estacionales de recolección de conchas en muestras arqueológicas. Una de estas técnicas hace uso de una especie de odostoma (*Boonea impressa*), un gasterópodo ectoparásito de la ostra que se recupera en los concheros al emplear métodos de recogida muy selectivos (luces de malla de 1-6 mm como máximo). Las medidas de longitud de concha de los odostomas arqueológicos han sido correlacionados con los resultados procedentes de estudios actuales sobre el ciclo de crecimiento del molusco. En última instancia esta metodología nos indica el momento de captura de las ostras por parte de los pobladores de los yacimientos. La técnica ha sido aplicada a una muestra procedente del yacimiento nº 5 del sitio Greenfield (8DU5541), un asentamiento precolombino de la costa atlántica nordoriental de Florida, U.S.A. Más de 6.000 odostomas fueron recuperados con los tamices de 1,6 mm. Las longitudes de las conchas apuntan a que las ostras fueron recolectadas entre los meses de verano a otoño tardío (julio-noviembre).

PALABRAS CLAVE: OSTRAS, ODOSTOMAS (*Boonea impressa*), ESTACIONALIDAD, CONCHEROS, FLORIDA

INTRODUCTION

Oyster reefs or bars are commonly found in estuaries and other nearshore brackish habitats along the Atlantic coast of the southeast United States. An abundant resource, oysters have been harvested in historic times for their flesh and still are commercially important today. Prehistorically, their conspicuous presence in many coastal archaeological sites indicates that oysters were also a prominent resource in subsistence economies of coastal populations long ago.

This study examines seasonal patterns of oyster collecting among pre-Columbian peoples living along the Atlantic coast of Florida. In particular, I focus on one of several methods that have been developed for determining season(s) of oyster harvesting in archaeological assemblages. This technique involves using measurements of the impressed odostome (*Boonea impressa*), an oyster parasite that is often found in archaeological oyster middens when fine recovery methods (1.6 mm mesh or smaller) are employed. Shell length measurements of archaeological odostomes are correlated with modern studies on the snail's annual growth cycle, ultimately indicating the season(s) in which oysters were collected by the site inhabitants. I apply the odostome method to the archaeological faunal assemblage from Greenfield Site No. 5 (8DU5541), a pre-Columbian site in northeast Florida, USA, in which very large samples of odostomes were recovered from multiple contexts.

In this paper, I give a brief discussion of the several methods used for determining seasonal patterns of oyster harvesting in archaeological contexts. Then I describe the Greenfield site and the recovery methods used. Next, I present the application of the odostome method to the Greenfield zooarchaeological assemblage and discuss the resultant findings. Finally, I address several issues that have been raised pertaining to the results obtained in odostome studies.

METHODS FOR DETERMINING SEASON OF OYSTER COLLECTION

At least three methods have been developed for determining season of oyster collection in archaeological middens: incremental shell growth structures; oxygen isotopes; and impressed odostomes.

The incremental shell growth method is based on the assumption that incremental breaks in oyster shell, visible on the hinge of the left valve, correlate with annual breaks in growth (also called annuli). Distances between annual growth breaks on archaeological oyster shell hinges are measured to derive growth indexes which are then compared to those of modern specimens to determine season of harvest (Kent, 1988; Lawrence, 1988; Custer & Doms, 1990; Herbert & Steponaitis, 1998). Although this technique has been successfully used in zooarchaeological assemblages from the mid-Atlantic region (Kent, 1988; Custer & Doms, 1990; Herbert & Steponaitis, 1998), it may not be applicable farther south along the Atlantic coast for several reasons. First, the method requires oysters to be at least 3 to 5 years of age at time of collection (Kent, 1988; Custer & Doms, 1990). In the Southeast, however, the faster growth rate of oysters allows individuals to reach edible size in 1 to 2 years (Quick, 1972; Russo, 1991a: 207; Kirby *et al.*, 1998). Second, oysters in the south Atlantic area usually occur in the intertidal zone of estuaries where they typically grow in clumps (Bahr & Lanier, 1981). These clumps consist of both live and dead shells (Bahr & Lanier, 1981; Russo & Saunders, 1989). Determining which archaeological shells were live and which were dead at time of collection can be extremely difficult (Russo, 1991a: 207-208). In the mid-Atlantic, however, oyster beds occur subtidally, and clumping is less common, so that direct measures of incremental growth may be more appropriate (Kent, 1988; Custer & Doms, 1990:152). Finally, in more northerly climates, growth breaks in oysters annually occur in the winter and are linked to cold weather stress (Kent, 1988). In the warmer Southeast, however, multiple growth breaks occur per year and may be linked to a number of causes, such as exposure to extreme cold or heat during periods of low tide (Russo, 1991a: 208; Andrus & Crowe, 2000: 37).

The stable isotope method is based on the assumption that oyster shells grow throughout the year in oxygen isotope equilibrium with the surrounding water (Surge *et al.*, 2001). Measurements of the ratio of ^{18}O to ^{16}O taken from the edge of shell samples are converted to relative temperature to give an indication of the season in which oysters were collected. This technique has been successfully used in zooarchaeological assemblages from the Georgia coast (Andrus & Crowe, 2000; Keene, 2002, 2004). This method, however, may be problematic in estuarine settings where there is the potential for freshwater inflow. Isotopic composition of shells may be influenced by freshwater input and water temperature (Andrus & Crowe, 2000; Surge & Lohmann, 2002).

The third method involves using shell length measurements of the impressed odostome and is the technique examined and applied here.

ODOSTOME METHOD

The impressed odostome (*Boonea impressa*) (Figure 1) is an ectoparasitic gastropod whose primary host is the eastern oyster (*Crassostrea virginica*) (Figure 2) (Robertson & Mau-Lastovicka, 1979; White *et al*., 1984) commonly found in shallow water reefs along the Atlantic and Gulf coasts of the United States. This snail's shell may also be found in archaeological faunal assemblages from oyster middens (Russo, 1991a). Attached to the shells of oysters collected for consumption by prehistoric populations, odostomes commonly became incorporated into archaeological deposits. Odostomes, however, are very small, typically measuring under 6 mm in length and less than 2 mm in diameter, and thus can only be recovered with fine mesh, that is, 1.6 mm or smaller, screens (Russo, 1991a: 213, 1992: 119). Because of the close association of this parasite with its host, a method was developed by Russo (1991a) that measures the modal size of impressed odostomes in archaeological faunal assemblages to determine the season(s) of capture of the oysters recovered in the same assemblage assumed to have been the snails' hosts.

FIGURE 2

Eastern oyster (*Crassostrea virginica*) archaeological remains top left: left valve, dorsal; bottom left: left valve, ventral; top right: right valve, dorsal; bottom right: right valve, ventral.

FIGURE 1

Impressed odostome (*Boonea impressa*) archaeological specimen.

Odostomes have a life span of approximately one year and grow at a predictable rate, increasing in shell length, throughout their life cycle (White *et al*., 1985). Growth rates and shell lengths from month to month over an annual cycle have been observed and recorded in several modern studies of live odostomes: at Beaufort, North Carolina, in 1955-56 (Wells, 1959); at Mud Island, Texas, in 1981-82 (White *et al*., 1984, 1985); and in northeast Florida in 1988-89 (Russo & Saunders, 1989; Russo, 1991a). The Florida study used in this research was conducted at the Matanzas River estuary in Crescent Beach, which is located along the Atlantic coast in northeast Florida and is approximately 40 km south of the archaeological site examined here. Live odostomes were collected monthly from intertidal oyster reefs over a 14-month period and their shell lengths measured. Using the modern odostome samples, Russo developed six seasonal size classes representing spring, summer, autumn, late autumn, winter, and late winter (Russo, 1991a).

Russo's study and other modern studies show that the principal cohort begins life in late spring and early summer (May and June). Their average size increases at a measurable and predictable rate throughout the year until spring of the following year when they die off and a new cohort appears. Consequently, their well-defined shell growth pattern can be used to predict season of death for odostomes and, in turn, season of death for oysters in archaeological faunal assemblages, that is, the season of oyster collection by the site inhabitants. For this purpose, Russo (1991a) used *modal* seasonal size classes as the descriptive statistical measure. Russo's method is applied here to several large samples of odostomes recovered from a site in northeast Florida to determine season of oyster collection, and, by extension, evidence for seasonality of site occupation.

THE ARCHAEOLOGICAL SITE: GREENFIELD SITE No 5 (8DU5541)

Greenfield Site No. 5 (8DU5541) is an oyster shell midden located on a peninsula near the Atlantic coast in northeast Florida (Figure 3). This peninsula lies 5 km southwest of the mouth of the St. Johns River, Florida's longest river. The site is situated within a live oak-magnolia hammock immediately adjacent to an expansive brackish marsh and tidal stream system, which surrounds the peninsula (Kirkland & Johnson, 2000).

The site consists of a series of discrete and overlapping midden deposits covering an area of approximately 175 m by 200 m. Radiocarbon dates and cultural remains indicate an early Woodland period occupation (500 B.C. to A.D. 100), represented predominantly by the Deptford culture with lesser representation of the coeval early St. Johns, or St. Johns I, culture (Kirkland & Johnson, 2000: 219-220). The distribution of ceramic types associated with these cultures, however, was scattered throughout the site, and, consequently, the two cultures could not be differentiated spatially or temporally. Clustering was not evident so that there was no indication that the two cultures had ever been spatially segregated on the landscape. Moreover, the mixed distribution of both ceramic series in the stratigraphic levels precluded any obvious vertical segregation, and therefore no separate occupation episodes were evident (Kirkland & Johnson, 2000: 60).

The type of settlement pattern (village or campsite) at Greenfield is not clearly indicated in the archaeological record. Evidence for permanent settlement such as domestic structures or specialized activity areas was not detected (Kirkland & Johnson, 2000: 224-225). Nevertheless, the site's rather large size and deep shell midden deposits suggest that the Greenfield site was intensively occupied for an extended period of time (Kirkland & Johnson, 2000: 219, 215).

The location of the site was probably selected by its pre-Columbian occupants because of its proximity to multiple environmental zones. The diverse hammock and marsh habitats surrounding the site supported their hunting-gathering-fishing way of life (Kirkland & Johnson, 2000: 56, 58, 223-224).

In the zooarchaeological assemblage recovered at Greenfield, oysters predominated, accounting for 98 percent of the MNI and 78 percent of the estimated edible meat weight (Fradkin, 1999). Because of the very large samples of odostomes recovered (over 6,000), the Greenfield site provided an excellent opportunity to apply the odostome method to determine season(s) of oyster collecting by the site inhabitants.

MATERIALS AND METHODS

Excavations were conducted at the Greenfield site in 1998 and 1999. Archaeological units were dug in 10 cm arbitrary levels within natural soil strata (Kirkland & Johnson, 2000: 53). The archaeologists removed column soil samples from test units having deep midden deposits and a high concentration of faunal remains (Kirkland & Johnson, 2000: 52). A 50 cm by 50 cm area was dug in 10 cm levels in the corner of each of these test units. There were a total of eleven 10 cm levels in each column sample. Also, soil samples were taken from each feature uncovered at the site. The soils from each column sample level and from each feature were processed in the lab by water-screening through a series of nested screens, 6.4 mm (1/4 inch), 3.2 mm (1/8 inch), and 1.6 mm (1/16 inch) mesh (Kirkland & Johnson, 2000: 52, 54-55).

All impressed odostomes were removed from the 1.6 mm zooarchaeological samples of 3 col-

FIGURE 3
Map of Florida showing location of Greenfield Site No. 5 (indicated by asterisk).

umn samples and 2 features (refuse pits) and submitted for analysis. My lab assistant took shell length measurements of all odostomes to the nearest tenth of a millimeter. We set up shell length size class increments following those established by Russo (1991a). Next, we tabulated and recorded the number of odostomes in each size class for each column sample and feature and then compared their frequency distribution.

RESULTS

A total of 6,524 impressed odostomes were recovered in the 1.6 mm samples at Greenfield. Table 1 presents the number of odostomes recorded for each size class for the entire site assemblage and their frequency distribution. Table 2 shows the modal length size classes and, in turn, the season(s) of oyster collection determined separately for each column sample and feature. These data are depicted graphically, plotted against a master seasonal graph developed by Russo (1991a). A separate graph is drawn for each sample (Figures 4-8), and then all the graphs are superimposed to examine the overall pattern (Figure 9). Comparing the archaeological odostome data to the modern modal size class data and Russo's master seasonal graph, the oysters in the Greenfield faunal assemblage were primarily collected in the summer, autumn, and late autumn months (July to November).

Season	Months	Size Class (mm)	# Odostomes
Spring	May/June	1.1 - 2.5	168
Summer	July/August	2.6 - 3.5	1587
Autumn	Sept/Oct	3.6 - 4.0	1415
Late Autumn	Oct/Nov	4.1 - 4.5	1514
Winter	Nov/Dec/Jan	4.6 - 5.0	1137
Late Winter	Feb/March/April	5.1 - 5.5	703
			6524

TABLE 1
Total number of odostomes by season for entire assemblage.

Provenience	Total # Odostomes	# Odostomes (%) in Modal Size Class	Collection Period
Column Sample 2	2831	648 (23)	Autumn-Late Autumn
Column Sample 4	2040	478 (23)	Autumn-Late Autumn
Column Sample 5	1296	290 (22)	Summer-Autumn
Feature 1	59	12 (20)	Autumn
Feature 11	298	67 (22)	Autumn-Late Autumn

TABLE 2
Season of oyster collection by provenience.

DISCUSSION

The analysis of the odostome samples indicate that pre-Columbian peoples at Greenfield were harvesting oysters in the summer through late autumn. These findings, in turn, support occupation of the site for, at least, those particular seasons of the year.

The Greenfield site was an ideal candidate for applying the odostome measurement technique as it yielded the greatest number of odostomes recovered at any Florida coastal site and thus provided several statistically valid samples for study. Indeed, the odostome method also has been applied to archaeological faunal assemblages from other oyster middens along Florida's Atlantic and Gulf coasts. Nevertheless, these studies involved much smaller odostome samples. Sample size ranged from approximately 30 to 300 odostomes in contrast to over 6,000 odostomes at Greenfield. As at Greenfield, most of these studies also indi-

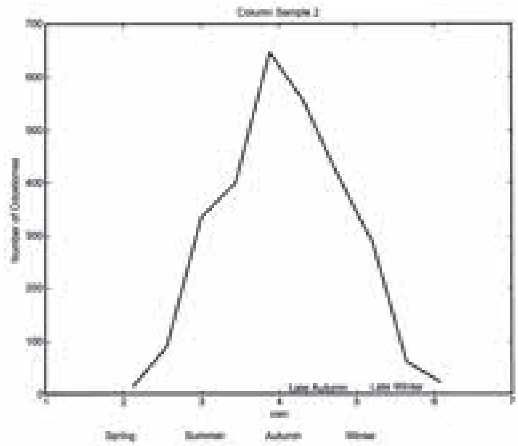

FIGURE 4
Column Sample 2 Odostome length size class distribution.

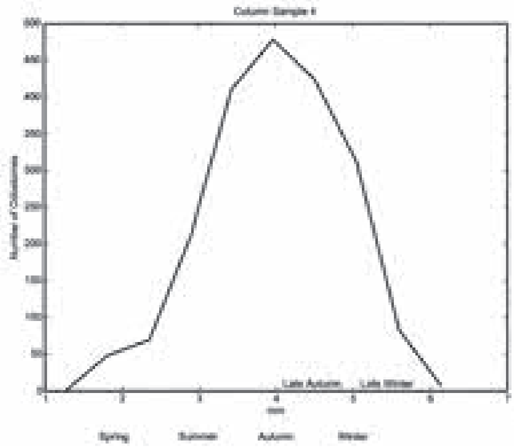

FIGURE 5
Column Sample 4 Odostome length size class distribution.

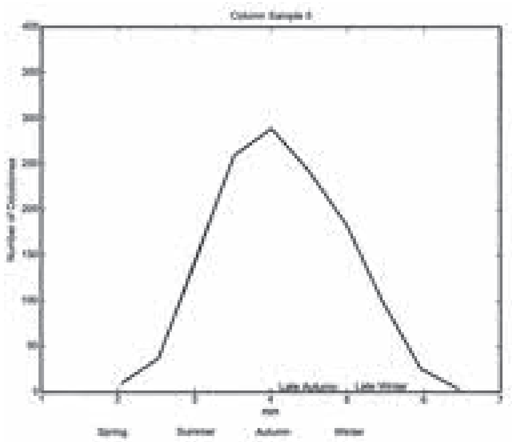

FIGURE 6
Column Sample 5 Odostome length size class distribution.

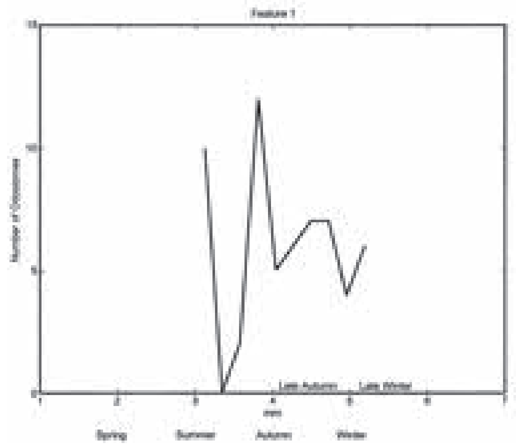

FIGURE 7
Feature 1 Odostome length size class distribution. Note: Graph for Feature 1 may be anomalous because of much smaller sample size (n=59).

cate that oyster collection occurred primarily in the summer and autumn seasons (Russo 1991a, 1991b, 1992, 1998; Russo *et al.*, 1993; Ashley & Rolland, 1997; Quitmyer, 2002; Ashley, 2004; Hendryx, 2004).

Several issues have been raised in regard to the results obtained in studies applying the odostome measurement technique to archaeological faunal assemblages. Keene (2002: 122-123) points out that these studies generally exhibit the same pattern, that is, a standard distribution of size class frequencies. She notes that there is a predominance of summer, autumn, and late autumn size classes and minor representation of winter, late winter, and spring.

Keene (2002: 122-123) suggests several possible reasons why the odostome measurement data tend to favor the median size ranges. In addressing the scarcity of the winter components in her own

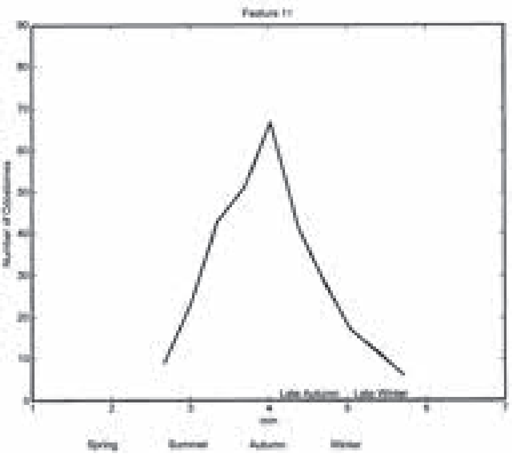

FIGURE 8
Feature 11 Odostome length size class distribution.

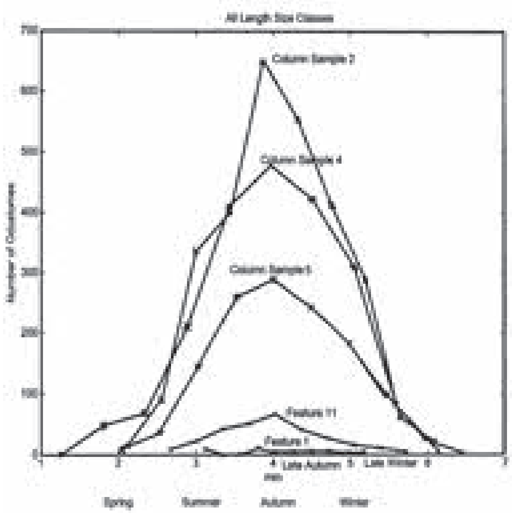

FIGURE 9
Comparison of all odostome length size class distributions.

samples from the Grove's Creek site on Skidaway Island, coastal Georgia, she refers to Wells' (1959) study of live odostomes collected in North Carolina. As in other modern odostome studies, Wells observed a continual increase in size of the principal cohort throughout its annual life cycle. Nevertheless, he also noted that, because of the mortality of larger individuals in the winter months, the *mean* average shell length size remained between 4 mm and 5 mm during this period (Wells, 1959: 142). So, according to Keene, the late autumn size classes may also include winter and late winter components, thereby inflating the late autumn percentage (Keene, 2002: 123). However, as previously discussed, the method developed by Russo (1991a) for archaeological faunal assemblages established seasonal size classes of odostomes based on *modal* rather than mean shell length.

A more critical question is the relatively low representation of the juvenile, or spring, component in archaeological odostome studies. The low spring percentage may be due to taphonomic processes, recovery methods, or the fact that pre-Columbian populations simply did very little oyster collecting in the spring. Taphonomic processes may affect the presence of juveniles in that younger shells are more fragile and break more easily (Keene, 2002: 123). The size of the fine mesh screens used for recovering odostomes is another critical factor (Russo, 1991a: 213, 1992: 119). At Greenfield, the finest screen size used was 1.6 mm. Consequently, very small shells may have passed through the screen, so that the juvenile, or spring, component may have been under-represented in the samples examined. Nevertheless, odostome studies conducted at other Florida coastal sites where finer mesh screens (< 1.6 mm, such as 0.7 mm) were used also had a low percentage of juveniles (e.g., Russo, 1991b, 1998; Russo *et al*., 1993). Such studies support the interpretation that oyster harvesting among pre-Columbian peoples was carried out to a much lesser extent in the spring season. Likewise, the inhabitants of Greenfield may have infrequently collected oysters in the spring.

SUMMARY AND CONCLUSIONS

Archaeologists have traditionally relied upon ethnohistoric documents, ethnographic analogies, ecological studies, and other indirect sources of information for developing models of seasonality, subsistence scheduling, and settlement patterns of earlier populations. More recently, several methods have been used which involve direct measurements of archaeological data. This study has demonstrated the applicability of one such technique in which shell length measurements of the impressed odostome, an oyster parasite, were used for determining season(s) of oyster harvesting in an archaeological faunal assemblage from the Atlantic coast of Florida.

Caution is still warranted when using odostome measurements. Recovery techniques can affect the juvenile, or spring, component which may be under-represented if very fine-gauge screens are not used (Russo, 1991a). In this study, 1.6 mm rather than finer mesh screens were used so that some very small juvenile shells may have passed through the sieve. Consequently, oysters may have been collected more frequently in the spring even though this was not indicated by the data.

In addition, care should be taken when drawing conclusions on seasonal patterns of site occupation based upon odostome measurements as these data solely indicate when one particular resource, oysters, was being harvested by the site inhabitants. It is essential to examine all faunal remains and thus other potential seasonal indicators in the zooarchaeological assemblage to determine whether the site was occupied in other seasons as well. For example, the presence of migratory birds may indicate winter occupation. When combined with other approaches, the odostome method is particularly helpful because it can be used to determine the season that the most ubiquitous and abundant faunal resource, oyster, was collected at coastal sites. As such, it measures the season of resource collection that took up much of the time and effort of the site inhabitants.

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