Journal of Archaeological Science: Reports 6 (2016) 637–644

Contents lists available at ScienceDirect

Journal of Archaeological Science: Reports

journal homepage: www.elsevier.com/locate/jasrep

Shell density as proxy for reconstructing prehistoric aquatic resource exploitation, perspectives from southern Africa

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ARTICLE INFO

Article history:
Received 18 April 2015
Received in revised form 1 June 2015
Accepted 5 June 2015
Available online 13 June 2015

Keywords:
Shell midden
Shellfish collection
Site formation
Settlement pattern
Deposition rates
Shell taphonomy
Prey transport

ABSTRACT

Aquatic resource use has gained enormous attention in recent years, particularly in terms of its role in human evolution. Significant strides are being made regarding the potential nutritional significance of aquatic foods for hominin diets, and explicit conceptual frameworks for understanding the evolutionary context of coastal adaptations are also being developed. Finding out when and where systematic use of aquatic resources took place and what constitutes a well-developed coastal adaptation requires a corpus of data that can offer insights into the organization of marine resource procurement. The earliest evidence for the exploitation of marine coastal habitats in the world is found in southern-most Africa (≤164 ka), where the most evident and abundant material expression of such foraging adaptation is revealed by marine mollusc shells found in mid to late Pleistocene archaeological sites. Hence, it becomes imperative to understand what can be meaningfully inferred from the variable quantities of such a significant component of early marine aquatic exploitation. This paper approaches the issue of aquatic resource use by investigating one of the most frequently employed quantitative measure for inferring such behaviour, namely shell density. Holocene assemblages from the South African west coast are used as a case study. It is found that shell densities can be misleading for inferring intensity of coastal resource use in the absence of palaeoshoreline reconstruction and when deposition rates are assumed to remain constant and when geomorphological and taphonomic contexts are unknown. Overall, deposition rates of marine shells is a better proxy for comparison between sites and through time, and thus for gaining insight into past marine coastal adaptations.

1. Introduction

Aquatic resources have been viewed as marginal until not too long ago, and the widespread appearance of shell middens along shorelines postdating the Last Glacial Maximum (LGM) was taken as indicative of their late systematic use once human population levels had increased substantially and apparently more productive terrestrial foods were depleted (i.e., Osborn, 1977). But archaeologists know by now that coastal resources have been exploited regularly since at least the Middle and Late Pleistocene as evidenced by the presence of shell-bearing sites in southern Africa (164 ka; Avery et al., 2008; Jerardino and Marean, 2010; Langejans et al., 2012; Henshilwood et al., 2014; Kyriacou et al., 2015) and Europe (150 ka; Colonese et al., 2011; Cortés-Sánchez et al., 2011). Hence, one of the main issues now revolves around the when and where systematic exploitation of coastal resources took place. Answering these questions requires reflecting upon definitions of what systematic exploitation of coastal resources is and how to go about detecting such an adaptation in the archaeological record. Methodological approaches for inter-assemblage and site comparisons on quantitative grounds thus need to be developed. An additional and important challenge to this endeavour in southern Africa, as elsewhere, is that much of this record has been lost or is unavailable due to successive postglacial sea level rise and flooding of the world's continental shelves (Bailey and Flemming, 2008; Fisher et al., 2010). When this record has survived thanks to steep bathymetry or other fortunate factors, its material expression could be nonetheless seriously compromised or obscured due to forager transport-mediated decisions. An increasing distance between campsites and shoreline is likely to have affected the choices of what and how much to bring back to campsites as ethnographic and archaeological studies show (e.g., Thackeray, 1988; Bird and Bliege Bird, 1997; Marean and Cleghorn, 2003; Lupo, 2007; Thomas, 2007; Dusseldorp and Langejans, 2013). This is an issue that cannot be dismissed when studying past shellfish collecting strategies in the context of changing coastline configurations as a result of sea level change.

Systematic exploitation of coastal resources has been equated with relatively large, localised and dense shell middens in association with faunal remains, artefacts and sometimes site features (Parkington, 2003; Jerardino, 2010a; Will et al., 2015). But it is not immediately apparent when shell dumps are dense and large enough, and/or sufficiently localised to reflect systematic exploitation of coastal resources.

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http://dx.doi.org/10.1016/j.jasrep.2015.06.005
2352-409X/

Alternative views propose that the sporadic use of coastal resources is not an indication of a coastal adaptation and that rather human lifeways ought to be transformed significantly (i.e., subsistence and settlement patterns, technology) through the focussed use of these resources and environments for a 'coastal adaptation' to develop (Beaton, 1985; Thompson and Worth, 2011; Marean, 2014). Hence, while some argue in terms of a continuum of increasing reliance on coastal resources and material expression of it, others propose a more operational view where once a particular socio-economic and technological threshold is reached resulting in the re-organization of adaptive systems around coastal resources, a full coastal adaptation is thus involved (Beaton, 1985; Thompson and Worth, 2011; Marean, 2014). Looking for changes in tool kits to answer these questions might not be productive as many coastal foraging strategies require simple technology (particularly shellfish collection) that often does not preserve well, especially in very early archaeological contexts (Waselkov, 1987). The comparative study of shell and faunal records offers more profitable avenues of research as these records are substantially more abundant than artefacts and are also reasonably well-preserved. Moreover, well-developed theoretical frameworks and methodologies can be used to reconstruct procurement and factors behind its variability in space and time (see Bird and O'Connell, 2006; Lupo, 2007).

When comparing coastal mollusc and faunal records, archaeologists working with the southern African Late Pleistocene and Holocene records have looked at relative frequencies or ratios of species and other proxy measures to evaluate possible marine emphasis in human diet (e.g., Jerardino, 2010b, 2012; Clark and Kandel, 2013; Dusseldorp and Langejans, 2013). However, no studies have yet attempted to meaningfully compare sites on the actual intensity with which resources were procured through time (quantities of preys procured in time). Intense and systematic use of such resources could well mean dependency on them and signal a coastal adaptation whichever definition is followed. The most frequently used proxy-indicators for identifying recurrent use or dependence on coastal resources (and several other types of food and also artefacts) have been density measures (weight or MNIs or NISP per unit volume) (i.e., Morwood, 1981; Schweitzer and Wilson, 1982; Sullivan, 1984; Glassow and Wilcoxon, 1988; Thackeray, 1988; Bailey and Craighead, 2003; Langejans et al., 2012; Faulkner, 2013; Marean, 2014; Will et al., 2015).

1.1. Shell densities and their meaning

A growing body of ethnographic data shows that not all collected shellfish is transported back to living areas as an important part of harvested shellfish are processed on the shore (de-shelled or 'shucked') (e.g., Bird and Bliege Bird, 1997; Thomas, 2007). Based on these observations, one of the obvious archaeological predictions that have been formulated is that reduced quantities of shells would reach campsites located at greater foraging distances. Hence, densities of mollusc shells at archaeological sites should decrease as distance between them and coastlines increase. Pleistocene records and preliminary observations among Holocene sites seem to broadly confirm these predictions (Thackeray, 1988; Smith and Mütti, 2009; Jerardino and Marean, 2010; Dusseldorp and Langejans, 2013). However, reconstruction of palaeo-shorelines and distances between them and sites have significant error margins, either because dating methods probing beyond the capability of the radiocarbon method have inherently large error margins (several thousands of years) and/or because bathymetric data are either coarse or some form of averaging is included in order to account for foraging radii along several kilometres of coastline that would have been accessible from a site (e.g., Fisher et al., 2010). Because sea levels rose and fell very quickly in a matter of a few thousands of years during interglacial and glacial stages, chronological inaccuracies can thus translate into flawed foraging distances and biased reconstructions of the past.

But density values are not without problems. The use of density values often assumes unchanging matrix composition, constant deposition rates and adequate preservation of archaeological residues (but see Parkington, 1988; Jerardino, 1995; Faulkner, 2013). Site matrix can be generated by people, such as dense shell deposits, or can have a significant natural component such as aeolian sand and roof spalling among others (e.g., Butzer, 1979; Hughes and Lampert, 1982). Hence, variability in the densities of shells or fauna may have little to do with the frequency with which prey was procured and brought back to the site, but rather depend on the rate of deposition of the dominant component of matrices which can change significantly over time as revealed by depth/age curves (i.e., Morwood, 1981; Sullivan, 1984; Stein et al., 2003).

In order to further explain the problems around the use of shell density, the following hypothetical cases are presented. For instance, two shell-bearing sites (A and B) of very similar overall size and depth of deposit show identical densities of marine shells and fauna, but one (A) accumulated over a period of time one order of magnitude less than the other (B). Clearly, the procurement of shellfish and other marine prey at site A was more intense than at site B, and that, consequently, marine resources were more systematically procured at site A while this was not (or much less) the case at site B. An alternative case is that of two other and similarly sized shell-matrix sites (C and D) with very different shell densities: site C has densities of marine shells and fauna one order of magnitude higher than site D, but accumulated over a period of one or two orders of magnitude longer than site D. Concluding that the exploitation of marine resources at site C was more intense than at site D based on density observations alone would be most likely erroneous, because shells and fauna accumulated (procured) at site C at a much slower pace than at site D. Either molluscs were procured with similar intensity at both sites, and site D received a more substantial non-anthropic input into its matrix (e.g., aeolian sand) than site C, or molluscs might well have been utilised more regularly at site D. Therefore, low-density shell deposits are not synonymous with a distant shoreline and/or infrequent collection of shellfish.

Similarly, the geological context of sites can also potentially complicate matters, as sites on or near coastal dunes are subject to more sand input and/or periodical deflation than caves and rock shelters, which can significantly alter original densities. Weight loss due to shell dissolution or burning, and contrasting densities among assemblages with dissimilar taxonomic composition and/or shell robustness could also compromise weight-density based comparisons and minimum number of individuals (MNIs) density comparisons could thus be more meaningful. Shell densities between assemblages screened with very different mesh sizes can also give spurious results, with smaller mesh sizes retaining greater shell quantities and thus yielding higher densities (see Jenkins, 2006). Most of these factors have yet to be studied for their potential impact on observed shell density values.

Given the large error margins associated with age determinations of Pleistocene sites and sometimes low geographic resolution of bathymetric data, it is crucial to test the above ethnographically-derived predictions on shell quantities and transport-mediated decisions with archaeological observations from shell middens that accumulated at a time when sea levels were stable. Ideally, shell assemblages ought to have been sampled with similar field methods from sites located at different distances from the coast, and studied using the same analytical methods. The best set of data in southern Africa to do this is the mid and late Holocene record from the West Coast of South Africa. A large number of shell middens in the Lamberts Bay and Elands Bay coastal areas have been excavated, extensively radiocarbon dated, their stratigraphic sequences described, and many of their shell bulk samples with associated volume information have been analysed and sometimes fully published. Sea level history and other contextual palaeoenvironmental and geomorphological observations are also available (Jerardino et al., 2013). Consequently, the objective of this paper is to approach the issue of systematic use of aquatic resources through