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The effects of sampling on the analysis of archeological molluscan remains: A quantitative approach

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ABSTRACT

Sampling is a practice that affects all stages of archeological research, and is a method frequently employed to manage the potentially vast quantities of material recovered from excavations. Current sampling methods used in the analyses of shell middens are largely based on those developed by the California School, and can be characterized by the implementation of small sample sizes during the excavation and analysis of shell deposits. The wider archeological sampling literature, however, has repeatedly demonstrated that the use of small sample sizes has the potential to result in the loss of substantial quantities of material, often grossly underestimating an assemblage's richness, and skewing abundance distributions. There is therefore a need to re-evaluate the current sampling methods used in the analysis of shell deposits. We use five ecological diversity indices to examine and quantify the effects of sampling on the recovery and interpretation of molluscan remains, using material from the Peel Island Lazaret Midden, southeast Queensland, as a case study. This research demonstrates that the use of small sample sizes does indeed affect measures of richness and evenness for molluscan populations, with marked differences being recorded for the two sample sizes used in this study. Results show that while subsamples are able to detect some trends in taxonomic richness and evenness, the degree of difference present between the results from the two sample size indicates that subsamples reduce interpretive accuracy. We conclude that, in addition to determining the appropriate sampling strategy during excavation or recovery of midden deposits as highlighted by previous research, there is also a need for researchers to assess sampling practices during the analyses of molluscan assemblages. The methods employed in this study can be easily applied and offer a robust means of determining the effects and adequacy of sampling.

1. Introduction

Sampling methods have the potential to affect archeological investigations at every stage of the research process, impacting the type of material recovered, the quality of the data recorded, and subsequent interpretations of sites and their assemblages (Orton, 2000:1). While issues surrounding various sampling procedures within the discipline have been discussed broadly, with a plethora of studies based on a range of archeological materials such as stone artifacts (Hiscock, 2001; Grayson and Cole, 1998), ceramics (Kirch et al., 1987; Lipo et al., 1997), and vertebrate remains (Grayson, 1981:116–167; Lyman, 2008:141–171), there has been very little discussion regarding sampling in archaeomalacology (e.g. Bailey, 1975; Bowdler 2006; 2014; Quitmyer, 1985). Few studies have examined the impacts of mollusk sampling methods on data quality (although see Hiscock, 2005; Poteate and Fitzpatrick, 2013). This is a distinct oversight considering the abundance of molluscs at archeological sites and the ubiquity of shell deposits worldwide.

The sampling procedures currently used for the analysis of molluscan remains in midden assemblages are largely based on those developed by the California School of midden analysis in the first half of the twentieth century (Ambrose, 1967:170). One of the defining characteristics of the California School was the ideology that shell deposits are homogenous in composition and structure (Gifford, 1916; Treganza and Cook, 1948). As a result, sampling methods developed by the School focused on the use of small sample sizes when collecting and analyzing shell mound material, with researchers arguing that small samples were representative of a deposit in its entirety (e.g. Cook and Treganza, 1947:292; Gifford, 1916; Cook and Treganza, 1947). While many of the sampling practices first established by the School have been refined over the years, such as the development of 'ideal' excavation pit sizes and subsampling procedures (e.g. Ambrose, 1967; Ascher, 1959; Bailey, 1975; Bowdler, 1983, 2014; Casteel, 1970; Cook, 1950; Cook and Heizer, 1951; Greengo, 1951; Greenwood, 1961; Heizer and Cook, 1956; Meighan, 1950; Meighan et al., 1958; Quitmyer, 1985), the use of small sample sizes (often less than 25% of deposit volume) continues in midden sampling strategies, despite more recent studies indicating that this is often not the case (e.g. Hiscock, 2005; Poteate and Fitzpatrick, 2013), due to the ongoing premise that shell deposits are structurally homogenous (e.g. Bailey,

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1999; Bernstein, 1993; Bowdler, 1983; Carter et al., 1999; Faulkner, 2013; Shiner et al., 2013).

Previous studies on the effects of sampling practices have highlighted substantial impacts on the recovery and subsequent interpretation of archeological assemblages when small sample sizes are used, possibly resulting in the significant loss of information, such as the representativeness of the assemblage composition and the relative abundances of taxa (e.g. Grayson, 1984:131–167; Kirch et al., 1987:126; Langley et al., 2011), skewing measures of richness and evenness (Grayson, 1981, 1984:158–167; Lyman, 2008:194–198). Given that mollusks often form large portions of archeological assemblages in coastal and riverine environments, and provide pertinent information regarding past economic and social practices (Claassen, 1998; Hiscock, 1997; Szabó, 2009; see also papers in Rick and Erlandson, 2008), as well as being important sources of information concerning paleoenvironmental conditions (Bourke, 2004; Faulkner, 2011; Gosling, 2003: 44–78; Hiscock, 1997; Morrison and Cochran, 2008:2395–2396; Sandweiss, 2003), it is clear that there is a need to understand the potential effects of sampling. This is highlighted in discussions by Driver (2011) and more recently by Wolverton (2013), concerning data quality in zooarchaeology. Both researchers stress the need for evaluation of methods used to generate data, emphasizing that uncritical use, and blind assumptions have the potential to generate poor quality results.

The aim of the research presented here is to examine the effects of current sampling practices on the recovery and interpretation of molluscan remains from archeological assemblages. In doing so, we build on previous midden sampling studies by Hiscock (2005) and Poteate and Fitzpatrick (2013), which examined the effects of sampling on a spatial level. What differentiates the research reported here, however, is its focus on the effects of subsampling practices on the recovery and interpretation of molluscan material. Using five ecological diversity indices commonly incorporated into archeological research (Number of Taxa, Rarefaction, Simpson's Index of Diversity, the Shannon–Weiner Index of Diversity, and the Shannon Index of Evenness), the extent to which sampling practices affect measures of richness and evenness is quantified through a comparison of two different sample sizes (20% and 100% of recovered material) using material excavated from the Peel Island Lazaret Midden, southeast Queensland, Australia, as a case study. The results of this study indicate that the use of small sample sizes, often seen with the common practice of subsampling material recovered through excavation of a midden deposit, can have significant impacts on measures of diversity. This signals the need for sampling strategies utilized during recovery, and the sizes of these samples, to be taken into consideration during all stages of data acquisition from excavation, recovery and subsequent analyses of molluscan assemblages.

2. The Peel Island Lazaret Midden

The Peel Island Lazaret Midden is located on Peel Island in Moreton Bay, Queensland, Australia (Fig. 1). The midden, extending over 200 m in length and 50 m in width, has been dated to 1200 cal. BP (Ross and Tomkins, 2011:137). Use of the site by the Aboriginal inhabitants of the bay continued up until colonization by European settlers in the mid-nineteenth century.

Ross and Aboriginal Traditional Owners of the island excavated the site as a community project between 1995 and 1999 (Ross and Coghill, 2000:77; Ross and Tomkins, 2011:136). The team excavated four 50 cm × 50 cm pits over several field seasons, with pits labeled A, B1, B4, and C (Fig. 1). These pits were excavated in arbitrary spits (levels) or "excavation units" (XUs) within stratigraphic contexts, with an average depth of 2 cm–2.5 cm, or approximately 9.5 kg by bucket weight (Ross and Tomkins, 2011:137).

The Peel Island Lazaret Midden displays four distinct stratigraphic layers (Fig. 2). Layer I extends from the surface to a depth of 5–6 cm and contains a layer of loose shell (Ross and Tomkins, 2011:137). Layer II ranges from 6 to 32 cm below the ground surface, and contains compact layers of shell. The final stratigraphic layer, Layer III (32–65 cm), contains only sparse quantities of shell in a soil matrix that becomes progressively denser with depth. Beneath layer III is sterile sediment (Ross and Tomkins, 2011:137).

All material was screened through 6 mm and 3 mm sieve fractions in the field, and material from the 3 mm sieve fraction was kept for further sieving in the laboratory. The 3 mm residue was passed through a 1 mm sieve and a 100 g sample of the fraction thus retained for each excavation unit was also analyzed. All material passed through the 1 mm sieve was also retained, but was not analyzed. As all excavated material was retained a 100% sample of the excavated assemblage was available for study. This 100% sample permits an analysis of a complete sample in comparison to subsamples taken from the complete assemblage.

3. Materials and methods

3.1. Material

The archeological materials analyzed in this study originate from the excavation of Pit B1 of the Peel Island Lazaret Midden, and uses the

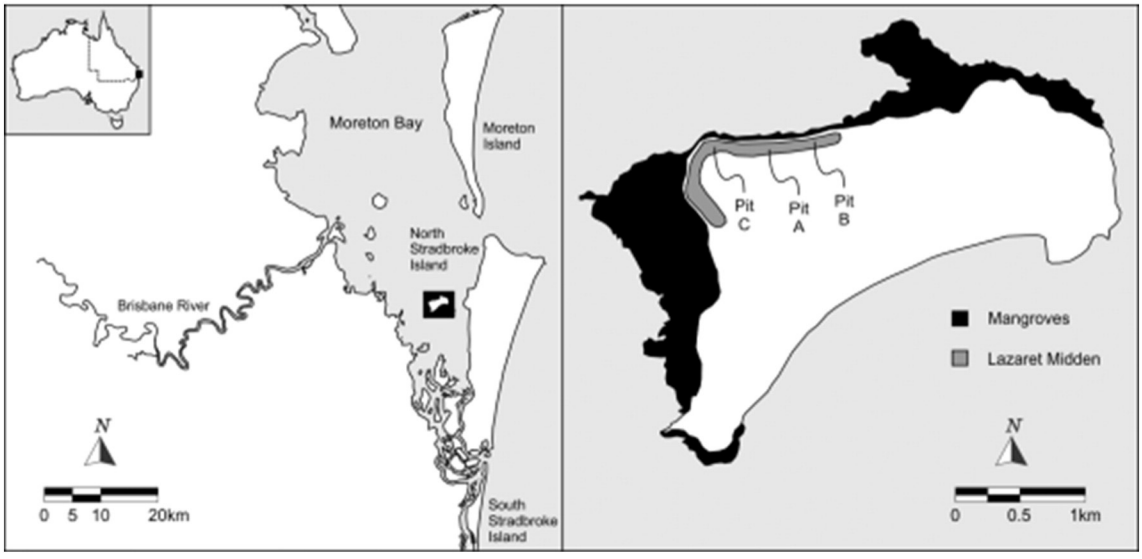

Fig. 1. The location of Peel Island within Moreton Bay (left); Distribution of the Peel Island Lazaret Midden and test pit locations (right) (after Ross and Tomkins, 2011:134, 136).

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