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Molluscs emergent, Part I: themes and trends in the scientific investigation of mollusc shells as resources for archaeological research

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ABSTRACT

The second most diverse phylum in the animal kingdom, the Mollusca occur in virtually all the environments which are either occupied or exploited by humans. The study of mollusc remains in archaeology has a long history, but the last 10–15 years has witnessed a proliferation of such studies, accompanied by a diversification both in the methods employed to analyse mollusc shells and the research questions they can help address. The analysis of shells of molluscs from archaeological contexts can potentially inform about the environmental, chronological, subsistence, behavioural and social contexts of people in the past; the latter three aspects being considered in Part II (Thomas, 2015). The principal research themes discussed in Part I are: palaeoenvironmental reconstruction; sclerochronology and sclerochemistry; radiocarbon dating of marine mollusc shells, the selection of shells for dating and calibrating the dates; and amino acid racemization dating. The focus is on current research themes and recent published output which are considered with a view to possible future developments.

1. Introduction

The principal aim of this overview is to highlight the diversity of current approaches to the analysis of mollusc remains in archaeological and archaeologically-relevant off-site contexts. It is not intended to be a traditional historical review based on significant 'foundation studies', but rather a state of the art assessment of present-day research themes along with some thoughts on future research developments. Where appropriate, recent comprehensive review articles are also highlighted, to which the reader can turn for an historical appraisal of developments within a particular topic.

Although the study of mollusc remains in archaeology has a long history, in the last few decades there has been a dramatic proliferation of such studies accompanied by a diversification in the methods employed and the research questions addressed. In consequence, there has been a significant increase in published output: as articles in internationally-significant journals or in compilations dealing with molluscs in archaeological and archaeologically-relevant deposits, some in books (e.g. Antczak and Cipriani, 2008; Bailey et al., 2013; Bar-Yosef Mayer, 2005; Çakırlar, 2011; Claassen, 1998; Davies, 2008; Roksandic et al., 2014) and others in special issues of scientific journals, such as those edited by Szabó and Quitmyer (2008) and Verdún-Castelló and Colonese (2014) or introduced by the editors (e.g. Álvarez et al., 2011; Codding et al., 2014; Gröcke and Gillikin, 2008; Schöne and Surge, 2005; West, 2013). The high quality along with the sheer volume of published work across a diverse range of archaeological applications compels me to divide this overview into two parts: the current article (Part I) considers the ways in which mollusc shells constitute a resource for archaeological scientists to analyse for environmental reconstructions and dating, while Part II (Thomas, 2015) deals with scientific investigations of molluscs and their shells as resources used by people in the past. Despite this division, it is necessary to be very selective in what can be included and I apologise to those colleagues whose excellent work has not been cited.

2. Mollusc shells: the medium and the message

Molluscs occur in virtually all the environments which were either occupied or exploited by humans in the past and those with hard, durable shells survive well in the archaeological and palaeontological records. In many parts of the world and in diverse environments, huge numbers of shells along with other materials accumulated by human activities have produced prominent topographic features often known as shell middens or mounds. Early

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studies of such sites in Denmark in the 19th century led to such accumulations being called '*køkkenmøddinger*', or 'kitchen middens' (Andersen, 2000). The term 'shell midden' became widely used to refer to heaps of shell, along with other materials, accumulated by human activities, with the term 'midden' implying that the shells were food refuse. Following critical reviews by scholars such as Claassen (1991), it is now accepted that many large shell mounds associated with a diverse range of past human activities were not just 'dumps' of discarded shells but were either deliberately constructed or were natural coastal storm ridges of shells that provided elevated and dry localities for subsequent human occupation (Sullivan and O'Connor, 1993).

This is not to suggest that all huge shell mounds, whether along maritime coasts, lake margins or river channels, are the consequence of natural processes augmented by subsequent human occupation. There are numerous examples of so-called megamiddens (e.g. in South Africa, Brazil, British Columbia, Florida and California) built-up by long-term human exploitation of shellfish and other resources. To avoid the dietary and refuse-dump assumptions implicit in the term 'midden', many workers prefer the neutral term 'shell matrix site', in which shells are the medium within which other categories of archaeological evidence (such as habitation structures and features, activity areas, ritual features, other categories of bioarchaeological remains, artefacts, and sometimes human burials) can also be preserved. In such cases, the shells are the principal medium for the preservation of evidence for a range of past human behaviours, settlement patterns, territories and social structures. The recent proliferation of multi-disciplinary studies of shell matrix sites in diverse regions of the world attests to their perceived importance, as exemplified by the Mediterranean (Colonese et al., 2011; a special issue of Quaternary International edited by Lubell and Barton, 2011); Atlantic Europe (Gutiérrez-Zugasti et al., 2011; Milner et al., 2007); the Arabian and Red Seas (Biagi, 2013, 2014; Biagi et al., 2012; Boivin and Fuller, 2009; Meredith-Williams et al., 2014); the Channel Islands of California (Erlandson and Colten, 1991; Erlandson and Glassow, 1997; Erlandson and Jones, 2002; Rick, 2007); Florida (Saunders and Russo, 2011) and Georgia (Reitz et al., 2012); Argentina (Briz Godino et al., 2011); Brazil (Wagner et al., 2011); Japan (Habu et al., 2011); and the tropical island Asia–Pacific region (Szabó and Amesbury, 2011).

The shells in such sites provide not only the medium for preservation but also messages about a diverse range of factors affecting human life in the past. This also applies to shells from sites in which they are a minority representation, for example a mere handful of marine shells in a site far distant from the sea. These diverse messages, how they are decoded and interpreted, are the principal focus of the remainder of this paper (Part I) and also Part II.

3. Molluscs in archaeology: the primary data

The Mollusca is a highly diverse group of animals, second only to the Arthropods in terms of numbers of species, and distributed across all habitable continents and in marine and freshwater environments. Major mollusc groups (zoological Classes) such as the chitons, scaphopods and cephalopods occur relatively infrequently in archaeological contexts compared with bivalves and gastropods. There is diversity in habitat requirements even at this level of classification: chitons, scaphopods and cephalopods are entirely marine, bivalves are entirely aquatic (marine, estuarine, freshwater), while the gastropods are highly variable. Prosobranch gastropods are taxonomically most diverse in marine environments, but there are numerous freshwater species and, especially in the humid tropics, many terrestrial ones. Opisthobranchs are entirely marine, many are shell-less 'sea slugs' but shell-bearing species can be represented in archaeological assemblages. Pulmonates are air-breathing gastropods and while the majority of species are terrestrial, there are many freshwater species and some marine (littoral zone) species. Descending the taxonomic hierarchy to the level of species, the diversity becomes great, with considerable zoogeographical differences between regional faunas. The ecological requirements of the various species are also highly variable, with some species being good indicators of quite specific environmental conditions while others are highly successful generalists.

4. Molluscs and the reconstruction of palaeoenvironments

Traditional reconstruction of past environments and human habitats is based on the ecological and environmental requirements of the various species of molluscs present, backed up by the relative or absolute abundance of each taxon, as well as the diversity of taxa, in assemblages. Changes in the geographical distribution of species over time may indicate climate or other environmental change, while changes in the relative representation of species in an assemblage could indicate local environmental changes or, if the shells are from edible species, shifts in the preferred loci of human foraging activity, various aspects of which are discussed in Part II (Thomas, 2015).

Past human environments at both macro- and micro-scales can be investigated using the smaller land and freshwater molluscs which are often associated with archaeological sites as part of the 'background fauna'. The palaeoenvironmental analysis of land snails has received most attention: see the comprehensive review by Davies (2008) which deals principally with Late Glacial through Holocene land and freshwater mollusc sequences in a wide range of terrestrial and freshwater depositional contexts as well as archaeological sites. The approach is essentially based on the habitat requirements of the different species of molluscs and on the proportions of broad ecological or habitat categories such as open-country species, shade-requiring species, wetland species, etc., in an assemblage. Such traditional analyses will continue to generate important information on the environmental settings of archaeological sites and regions, and human impacts upon them, especially when high-resolution sampling and multi-proxy approaches are adopted, for example in calcareous tufas (Dabkowski, 2014), or when comparisons of successional sequences are made across different parts of the same depositional system (e.g. Granai and Limondin-Lozuet, 2014). The following sections deal with additional scientific approaches to past human environments and human activities within them through the analysis of the growth patterns and chemical characteristics of mollusc shells.

5. Sclerochronology: time for tracking change

Andrus (2011) defines sclerochronology as "the study of information preserved in the accretionary growth of skeletal materials, often including geochemical analyses, to construct time-series data profiles". Other definitions exist, some differentiating between 'sclerochronology' as the study of the physical organisation of the accretionary hard tissues of organisms (such as periodicities of growth lines) and 'sclerochemistry', the application of isotope or elemental analyses to sclerochronological growth series (e.g. Gröcke and Gillikin, 2008). Since publication of the definitive "Skeletal Growth of Aquatic Organisms" (Rhoads and Lutz, 1980) there have been many developments in the field of sclerochronology involving a diverse array of scientific disciplines including Archaeology, Biology, Climatology, Ecology, Environmental Sciences, Geochemistry, and Paleontology, among others. Sclerochronological analyses have been applied to a range of animal