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Molluscs emergent, Part II: themes and trends in the scientific investigation of molluscs and their shells as past human resources

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ABSTRACT

Recent work in three major research themes involving molluscs is reviewed: 1. molluscs in past human diets and subsistence systems, sclerochemistry and seasonality studies on mollusc harvesting times using stable isotopes of oxygen; 2. the impact of foraging on mollusc populations, resource management strategies, and settlement patterns and mobility of coastal foragers; and 3. mollusc shells as artefacts and personal ornaments, including manufacture and use, provenance studies and exchange systems, and human cognition. Most of the discussion is about marine molluscs and their shells, although land snails and freshwater shells are also considered, where appropriate.

1. Introduction

Part I of this overview of recent trends in the investigation of molluscs in archaeology (Thomas, 2015) focused on mollusc shells as objects for scientific research and dealt with themes such as sclerochronology and sclerochemistry, palaeoenvironmental reconstruction, and methods for obtaining absolute chronological dates from shells. In this second part, some of these are applied to the investigation of molluscs and their shells as resources for past human populations.

2. Molluscs in past human diets and subsistence systems

Large and impressive accumulations of shells of edible species of molluscs could, if taken at face value, indicate they were a significant food resource. This can be misleading, as shown for example by Bailey's (1975) analysis and dietary modelling of an oyster mound in New South Wales. To take just one of Bailey's alternative models: with a population of 100 people, the site could have been occupied for 7 days per year if the calorific contribution made by oysters to the daily requirement was 100%, or for 140 days per year if it was only 5%. Meehan (1982, 159), however, pointed out that there are many more facets to diet than calories alone and shellfish provide important nutrients such as proteins and trace elements, as well as being available and easily procured at all times of the year, with access not being limited either by the skill of the gatherer or the behaviour of the prey.

Another complexity for evaluating molluscs as items in past human diets is that the molluscs present in large shell accumulations may not reflect either the quantity or the full range of species consumed. Ethnoarchaeological studies (e.g. Meehan, 1982; Bird and Bliege Bird, 1997) show the consumption of considerable quantities of shellfish away from occupation sites. Bird and Bliege Bird (1997) found that shells of species with high processing costs tend to be relatively over-represented at home bases while species with low processing costs were processed near the place of collection.

2.1. Marine molluscs in past human diets: they were what they ate

The relative importance of marine molluscs and other marine foods in past human diets is increasingly being investigated through what people actually ate. Marine foods carry characteristic signatures, especially in the stable isotopes $\delta^{13}C$ and $\delta^{15}N$, which can be recorded in human bone collagen. Isotope studies of human bones suggest that marine foods were important in late Mesolithic

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diets along the Atlantic coast of Europe (Dupont et al., 2009; Richards and Hedges, 1999; Richards et al., 2005). By contrast, the isotopic evidence from prehistoric people (often buried in shell-rich deposits) in the Mediterranean region indicates that marine foods played a minor role in overall diets (Colonese et al., 2011; Mannino et al., 2011a, b; 2012; Stiner and Munro, 2011). Krigbaum et al. (2013) demonstrated a marine-based diet with no significant differences between males and females for a site in the Lesser Antilles, Caribbean. Similar results were obtained by Choy et al. (2012) for a Neolithic site in Korea, where there was a strong dependence on marine protein sources, but again with no differences between females and males. Zooarchaeological data from late Holocene sites in the San Francisco Bay Area show an increase in diet breadth over time (Beasley et al., 2013) with $\delta^{13}C$ and $\delta^{15}N$ in human bones revealing dietary variability between individuals in their marine and terrestrial food consumption, although this was independent of sex. All these studies were on coastal sites, but sites distant from the coast may contain remains of marine foods (molluscs and fish), such as some Mesolithic sites in eastern Iberia some 30–50 km from the modern coast, with human bone $\delta^{13}C$ and $\delta^{15}N$ indicating that while terrestrial foods were most important, there was a measurable protein input from marine sources (Salazar-García et al., 2014).

In a particularly high-resolution study of past human diets, seasonal variations of $\delta^{13}C$ and $\delta^{15}N$ were analysed in growth increments of well-preserved archaeological human hair from Andean sites in S. Peru (Knudson et al., 2007). $\delta^{15}N_{hair}$ revealed variations between individuals: some had consumed principally non-marine animal foods throughout the period of hair growth, others had diets which were dominated by marine foods, and a few had eaten significant amounts of marine foods in the last few months of life, and also 20–26 months before that, but mostly non-marine foods in between. There was no evidence that marine molluscs contributed significantly to any of the $\delta^{15}N_{hair}$ marine values.

In interpreting such studies, it must be remembered that because most marine molluscs are either primary consumers or detritivores with $\delta^{13}C$ and $\delta^{15}N$ values close to those of marine algae and plants, their consumption by humans would give only a weak 'marine food' isotope signal as compared with higher trophic level marine carnivores. It seems unlikely that a distinct dietary indicator for the consumption of molluscs will be found, but who knows what some ingenious biochemist or nutritional scientist might discover.

2.2. Land snails in past human diets

The existence of large prehistoric land snail 'middens' has, quite reasonably, been accepted as showing their role in human subsistence (e.g. Lubell, 2004). The evidence for the prehistoric consumption of land snails can, however, be ambiguous. Some workers (e.g. Fernández-López de Pablo et al., 2011; Gutiérrez Zugasti, 2011; Lloveras et al., 2011) suggest that accumulations of large and adult shells in a deposit indicate deliberate selection by humans for food, while others (e.g. Bonizzoni et al., 2009; Girod, 2011) are more sceptical and urge an evaluation of all the land snails in a deposit to distinguish natural assemblages from anthropic ones. This is a particular problem with cave and rockshelter sites, which provide a suitable microenvironment for land snails to aestivate during hot dry summers or hibernate during winter. Experiments by Rizner et al. (2009) sought to identify characteristic signatures of cooking on shells by boiling and roasting live specimens of *Helix* (species unspecified); boiling left no identifiable traces on the shells, roasting in the embers of a fire for around 5 min was sufficient to cook the flesh of the animals but caused little change to the external surfaces of the shells, while roasting for 10 min resulted in the flesh being burnt and the shells becoming unstable. There is a need to clarify and agree upon criteria which indicate that land snails were indeed items in past human diets, which will probably relate to specific stratigraphic associations between large land snails and other archaeological materials and also, possibly, to some sort of physical or chemical 'signature' in shells which indicates cooking.

2.3. Food for thought: shellfish and the development of the human brain

Recent research has suggested links between coastal foods, human nutrition and the evolution of the human brain. Polyunsaturated fatty acids, in particular docosahexaenoic acid (DHA), appear to be essential for brain function in humans and other mammals and it has to be acquired from food (Brenna and Carlson, 2014). While terrestrial plants produce negligible quantities of DHA, littoral-zone single-celled organisms and plants produce plentiful amounts. The role of marine molluscs in providing such essential compounds, as well as important proteins and micronutrients (especially iron) is considered by Kyriacou et al. (2014) and, while further consideration cannot be made here, this could rejuvenate old debates about the role of sea-shore habitats in hominin, and especially human, evolution.

2.4. Sclerochemistry and the seasonality of mollusc harvesting

Isotope data ($\delta^{18}O$) on season of harvest of molluscs are becoming widely applied and integrated into zooarchaeological studies and models of past human subsistence, although modern validation research is necessary for many species of archaeological significance (Andrus, 2011). The basic concept is very simple: when a mollusc is harvested by a forager it stops growing, so the $\delta^{18}O$ signatures in the final growth increment of its shell should indicate approximately when in the year it died. To determine seasonality of collection it is essential that the $\delta^{18}O$ values in the shells record temperatures all year round, in other words that the shells grow all year round, and often it is necessary for researchers to undertake field-based ecological studies to confirm this, as discussed in section 5 of Thomas (2015). An impressive field-based actualistic study of the bivalve *Saxidomus gigantea* (Deshayes) by Hallmann et al. (2009) showed that high-resolution analyses based on micro-sampling of fine growth increments have the potential for detecting collection not only in specific seasons but even during specific tides. In general, bivalves (especially infaunal species) offer the greatest potential for high-level resolution of shell growth intervals and associated sclerochemical data, although gastropods are increasingly being investigated (e.g. Maninno et al., 2008).

A number of rather basic but important factors need to be borne in mind when using $\delta^{18}O$ in shells for studies of seasonal patterns of shellfish exploitation, such as the appropriate sample sizes required in relation to the research questions to be addressed, the complexity of the site or the sites in a region, and the chronological span of the occupation phases under investigation. For example, a study of the seasons of collection of the bivalve *S. gigantea* across five archaeological sites in the Dundas Islands Group, British Columbia, led Hallmann et al. (2013) to conclude that shells were collected year-round through some 6000 cal radiocarbon years of occupation across the sites, and that there was no difference in seasonal patterning between small and large shell middens. High-resolution sclerochronological data ($\delta^{18}O_s$) in shells from these sites showed changes in climate through the Holocene, despite which a consistent pattern of shellfish harvesting is said to have been maintained. This is an interesting study, with equally interesting conclusions, although the inference of aspects of seasonal