

A site for all seasons? Prehistoric coastal subsistence in northwest Sicily

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There has been much debate about the role of marine resources, including shellfish, in prehistoric human diets, but there have been few studies that combine archaeological and present-day ecological investigations of coastal sites. This dual approach is being applied in a new field- and laboratory-based project that focuses on a group of coastal sites in northwest Sicily.

Evidence from stable isotope analysis¹ of human bones of late Mesolithic date from a range of archaeological sites along the Atlantic coast of Europe indicates that marine foods contributed significantly to the diet, in marked contrast to later Neolithic populations who evidently subsisted on terrestrial resources. The late Mesolithic individuals, whose bones were analyzed, probably ate mostly fish, with marine molluscs (shellfish) constituting a relatively minor part of the diet.² This inference contrasts with evidence from the analysis of marine molluscs from the Mesolithic site of Culverwell in southern England, which suggests that they were exploited regularly, and sufficiently intensively to have an impact on the local mollusc populations; and analysis of the stable oxygen isotopes in shell carbonates of the top shell (*Monodonta lineata*), one of the principal species found at Culverwell, suggested that the molluscs were exploited mainly during the autumn and winter.³

Studies such as these have highlighted the potential significance in prehistoric subsistence of marine resources, although the available database of sites is limited mainly to the Mesolithic period and usually to individual sites, with the notable exception of studies of clusters of sites along the Cantabrian coastline of northern Spain.⁴ There is abundant evidence of prehistoric exploitation of coastal resources

in the Mediterranean region, but there too the work done has tended to focus on particular sites, such as Franchthi Cave in southern Greece and the Grotta dell'Uzzo in Sicily.⁵ There is a need to take a broader view of prehistoric human coastal palaeoecology, based on the study of subsistence change over time within well defined regions that contain many archaeological sites spanning the Upper Palaeolithic, Mesolithic and Neolithic periods. We have identified northwest Sicily as a region that meets these criteria.

The regional context

Northwest Sicily has one of the highest densities of prehistoric coastal sites in western Europe, and probably in the Mediterranean as a whole, and it offers enticing possibilities for the systematic examination of prehistoric human coastal adaptation. Many of the coastal cave sites of northwest Sicily have been excavated, and most were found to contain abundant remains of shellfish, probably brought there for consumption. There are radiocarbon dates for a few of these sites, but most chronological sequences are based on stone-tool typologies.⁶ Several caves contain stratigraphical sequences that span the period from the end of the Palaeolithic (Epigravettian) to the Neolithic, but in others only one or two major cultural phases are represented. Apart from the stone artefacts and (in a few caves) notable rock art, and with the exception of the Grotta

dell'Uzzo, little is known about the prehistoric occupants of the caves, or about their economy and environment. Excavations in the past have yielded substantial quantities of material that have yet to be studied, among which are large collections of shells of marine molluscs.

Aims and methods of the project

Our project has two major components:⁷

- the analysis of assemblages of marine shellfish from archaeological sites
- the ecological study of selected analogous coastal localities.

A first priority has been to select the sites to be studied, on the basis of reliable excavation data, the abundance and good state of preservation of shell materials, the archaeological period(s) represented, and the spatial relationships of sites. Four main clusters of sites have been selected and, within these clusters, key sites have been identified that we are either already studying or plan to study in the course of the project (Fig. 1, Table 1). The sites were chosen because they have been reliably excavated and because several of them have long sequences of occupation that span several cultural phases. One or two additional sites will be selected for study in each of clusters 2, 3 and 4, for comparison with the corresponding key site in each cluster. Because few of the sites have previously been dated by radiocarbon or other methods of absolute dating (Table 2), an important part of the project is to use suitably preserved shells from important stratigraphical units at selected sites for accelerator mass spectrometry (AMS) radiocarbon dating (which is capable of accurately dating extremely small samples).

The archaeological assemblages of shells are being subjected to taxonomic and biometric analysis. Laboratory studies of shell mineralogy are also being undertaken, to facilitate the selection of suitable shells from the assemblages for radiocarbon dating and for the analysis of stable isotopes of oxygen. The oxygen isotopes will provide palaeoclimatic information, such as a record of variations of seawater temperatures, and also data on the seasons when molluscs were gathered at particular sites (Fig. 2). These investigations are complemented by ecological, biometrical and isotopic studies of present-day local populations of molluscs.

Two shore localities in northwestern Sicily have been selected for long-term study, one on the island of Favignana and the other on the Sicilian mainland at Monte Cofano (Fig. 3). These are visited monthly to study changes in mollusc populations over two annual cycles. This includes recording species present, relative species abundance, changes in biometrical variables and age profiles, and periods of recruitment to the populations (when the planktonic larvae settle on the shores and metamorphose into tiny juvenile molluscs). The species *Monodonta*



Figure 1 Northwest Sicily, showing the location of the archaeological sites currently being studied and of the two localities (Cala Grande, on the island of Favignana, and Monte Cofano, on the mainland) where ecological surveys are being undertaken.

Table 1 Sites in northwest Sicily with evidence of the prehistoric exploitation of marine resources.

<p>Site cluster 1: Termini Imerese Riparo del Castello (excavation; Epigravettian, Mesolithic?, Neolithic; two radiocarbon dates) Grotta Geraci (excavation; Epigravettian to Neolithic) Grotta Natale (excavation; Epigravettian) Grotta Puleri (excavation; Epigravettian, Neolithic) Grotta di Nuovo (excavation; Epigravettian)</p>	<p>Site cluster 2: Conca d'Oro The Adaura caves (Epigravettian, Mesolithic?; rock art) Grotta Molarà (excavation; Epigravettian, Mesolithic?, Neolithic, Bronze Age; radiocarbon dates; burials: Mesolithic human remains and dental wear) Grotta Niscemi (excavation; Epigravettian, Mesolithic?; rock art) Grotta Perciata (excavation; Epigravettian, Mesolithic?; radiocarbon date; rock art), Grotta S. Ciro (excavation; Epigravettian), plus many other caves (Epigravettian, Mesolithic?) with marine shells</p>
<p>Site cluster 3: Monte Cofano and the Uzzo Cave Grotta dell'Uzzo (Mesolithic, Neolithic; radiocarbon dates; burials: Mesolithic human remains, bone chemistry and dental wear) Grotta Mangiapane (Epigravettian; small excavation), Grotta Emiliana, Grotta Martogna, Grotta di Cala Mancina, Grotta Racchio (rock art), Grotta Scurati, Grotta Perciata, Grotta del Crocifisso</p>	<p>Site cluster 4: Isole Egadi: Levanzo and Favignana Grotta di Cala dei Genovesi (Layer 3 Epigravettian, radiocarbon date; Layer 2 Mesolithic; rock art) Levanzo: Grotta di Punta Capperi, Grotta dei Porci, Grotta di Punta Sorci, Grotte di Cala Tramontana (small excavation) Favignana: Grotta delle Pecore, Grotta dell'Ucceria, Grotta d'Oriente</p>

Table 2 Dates in uncalibrated radiocarbon years before present from Upper Palaeolithic and Mesolithic sites in Sicily, and Neolithic sites in northwest Sicily (from Tusa, 1994: n. 6 below); most of the radiocarbon determinations are on charcoal samples.

Epigravettian (all Sicily)		Mesolithic (all Sicily)		Neolithic (northwest Sicily)	
Grotta dell'Acqua Fitusa	13760 ± 330	Grotta dell'Uzzo	10070 ± 90	Grotta dell'Uzzo (transition)	7910 ± 70
Grotta Giovanna	12840 ± 100	Grotta dell'Uzzo	9300 ± 100	Grotta dell'Uzzo	6750 ± 70
Grotta Perciata	11960 ± 330	Grotta dell'Uzzo	9180 ± 100		
Grotta di Cala dei Genovesi	11180 ± 120	Grotta dell'Uzzo	9030 ± 100		
		Grotta dell'Uzzo	8330 ± 80		
		Grotta dell'Uzzo (Burial 4)	9500*		
		Grotta dell'Uzzo (Burial 1)	8600*		
		Grotta della Molarà	8600 ± 100		

* Aspartic acid racemization dates on human bone from Mesolithic burials.

turbinata has been selected for intensive study at these localities and also in the archaeological material. It has been used in previous isotope studies⁸ and has been shown to record significant shifts in oxygen ratios, which appear to be correlated with changes in seawater temperature. It is also a species known to be abundant in the archaeological assemblages that we are studying.

Live *M. turbinata* molluscs have been individually marked and released at both localities for the study of patterns of shell growth. Some of the molluscs will be collected at the end of the ecological study, and shell-carbonate samples from them will be analyzed for fluctuations in stable carbon and oxygen isotope ratios over the known period of growth. The resulting data will reveal how accurately the isotope ratios track annual temperature changes, and therefore how indicative they may be of seasonal patterns of shell growth. In parallel with this long-term study of marked shells, other shells are being sampled at each monthly visit to investigate how stable-isotope ratios of oxygen and carbon in samples of shell-edge carbonates vary over annual cycles, for which purpose seawater temperatures are recorded monthly, and samples of sea water are taken for oxygen isotope analysis and salinity determinations. These various sets of data will help to calibrate the palaeo-isotope data for both palaeo-temperature reconstructions and estimates of season of death of the molluscs in the archaeological assemblages.

The main archaeological and palaeo-

ecological questions and hypotheses to be addressed using the data collected fall into three groups:

- What were the patterns of mollusc exploitation within each cultural phase, both within individual sites and within and between the clusters of sites? Subsidiary questions that then arise are: (1) Might any differences in isotopic seasonal patterns within and between clusters suggest the presence of different social groups (with resource territories) in the whole region? (2) Do the molluscs from sites that have rock engravings or burials or both (i.e. sites where ritual activities may have taken place) show different patterns of shellfish exploita-

tion, including seasonal differences, compared with other sites in the same cluster? (3) Do the data therefore lend support to the idea that such ritual sites could have been associated with particular social groups, whereby each local group in effect owned a ritual cave or caves? This inference would be reinforced if ritual sites across the whole region were found to have broadly similar patterns of seasonal use. Conversely, if the seasonality data suggest that ritual sites across the region were used at different seasons one might infer that regional patterns of ritual activity occurred independently of any local resource territories.

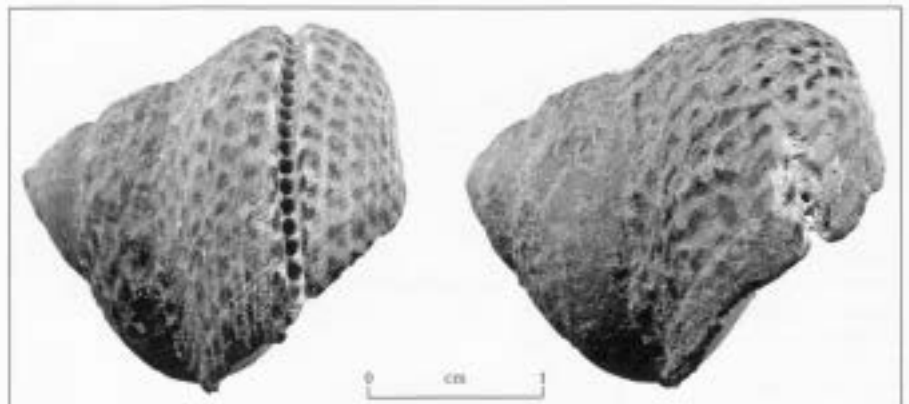


Figure 2 Shells of *Monodonta turbinata* sampled for shell carbonates (the small circular holes show where the shells have been sampled); (left) shell sampled for a long sequence of $\delta^{18}O$ values (see results in Fig. 5); (right) shell sampled for an edge series of three samples to determine in what season(s) it was gathered.



Figure 3 View northeast across the Golfo di Cofano: the ecological survey site of Monte Cofano is on the rocky shore in the foreground and several of the archaeological cave sites are located at the foot of the peninsula in the background.

- How did patterns of shellfish exploitation change between cultural phases? Subsidiary questions include: (1) Can any changes in exploitation strategies between the Upper Palaeolithic and the Mesolithic be attributed to environmental change, such as rising sea level, or are other factors involved, such as resource depletion? (2) Can any changes in exploitation between the Mesolithic and the Neolithic be associated with the adoption of agriculture? In particular, did such exploitation become more specifically seasonal at that time? If so, how might this be related to the seasonality of agricultural production or the likely seasonal longevity of stored agricultural products?
- What changes in the exploitation of shellfish, if any, occurred in particular cultural phases? Subsidiary questions include: (1) Were molluscs exploited year-round or seasonally at individual sites? (2) Are any patterns of seasonal exploitation identical between sites within clusters? (3) Are patterns of seasonal exploitation consistent between sites across clusters? (4) Do patterns of seasonal exploitation between sites within clusters differ, suggesting the possibility of movement between sites at different times of the year. (5) If so, are patterns of seasonal exploitation between sites within clusters such that they could have taken place throughout an entire year, suggesting the possibility of year-round occupation of coastal zones and exploitation of intertidal resources?

The results from these various investigations are currently being gathered and analyzed, so it is premature to draw any specific conclusions at this stage. However, some preliminary results are available and in the next section we present some

of them from both the present-day seasonality studies and from the Grotta dell'Uzzo.

Preliminary results from the seasonality studies

Figure 4 shows the variation over one annual cycle in the ratio of the stable isotopes of oxygen (i.e. of ^{16}O and ^{18}O ; expressed as $\delta^{18}\text{O}\%$) in shell-edge carbonate samples from living *Monodonta turbinata*, compared with the monthly changes in seawater temperatures, at one of the localities being studied, Monte Cofano. It is clear that the monthly $\delta^{18}\text{O}$ values are strongly correlated with monthly seawater temperatures, suggesting that $\delta^{18}\text{O}$ values in shell carbonates from archaeological specimens are likely to be good proxy indicators of past seawater temperatures and also season of death of individual shells (i.e. when they were collected).

Figure 5 shows the variation in $\delta^{18}\text{O}$ values through a sequence of shell carbonate samples from an archaeological shell from the Grotta dell'Uzzo. The data show clear fluctuations in $\delta^{18}\text{O}$ values over at least one year of shell growth, indicating that these values probably indicate past temperature changes. Similar analyses are being carried

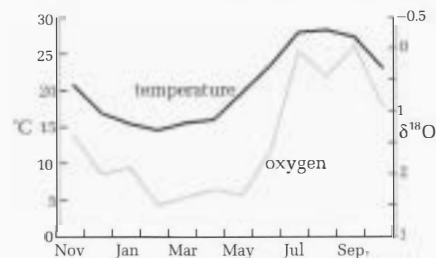


Figure 4 Monthly variations in seawater temperatures and in the oxygen isotope ratios ($\delta^{18}\text{O}$) in shell-edge carbonate samples from living molluscs from Monte Cofano.

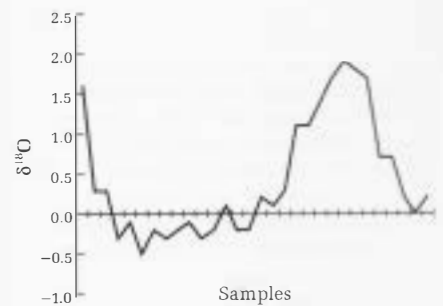


Figure 5 Variation in the oxygen isotope ratios ($\delta^{18}\text{O}$) in sequences of samples taken at 1.0mm intervals back from the shell edge (the left-most sample) in a shell from the Grotta dell'Uzzo (Neolithic occupation phase). The $\delta^{18}\text{O}$ values reflect slightly more than a full year of shell growth; the lowest values indicate periods of summer growth and the highest values periods of winter growth.

out on shells from each of the main occupation layers at the site, to yield a framework of isotope values for each layer. These will be used to indicate general patterns of change in seawater temperatures between layers (and, by inference, likely climatic shifts over time), as well as to provide for each layer an annual pattern of isotope values against which the shell-edge isotopic values can be assessed for seasonality. Figure 6 shows the distribution of shell-edge isotope values in the shells analyzed so far from the Grotta

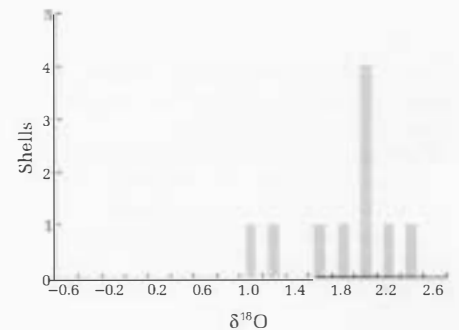


Figure 6 Histogram showing the frequency distribution of shell-edge oxygen isotope ratios in ten shells from the Neolithic occupation phase at the Grotta dell'Uzzo. The $\delta^{18}\text{O}$ values shown represent the total range of possible values for the Neolithic phase, as determined by analyses of shell sequences (as in Fig. 4). The clustering in the higher part of the range of $\delta^{18}\text{O}$ values shows that many shells were collected as food in the winter period, while those shells in the middle part of the range were collected in the autumn (as deduced from the $\delta^{18}\text{O}$ values in the second and third samples taken back from the shell edge). No shells occur in the summer part of the range of $\delta^{18}\text{O}$ values. Although interesting, these results must be regarded as preliminary, pending the analysis of a larger sample of specimens.

dell'Uzzo. There is a marked clustering in the higher region of the possible annual range of values, suggesting that collection occurred in the autumn–winter period. In order to distinguish between spring and autumn collection, three successive carbonate samples are taken at, and back from, the shell edge. If the pattern of change towards the shell edge is one of increasing $\delta^{18}\text{O}$ values, indicating progressive cooling, an autumn season of death is indicated. If the results show lower $\delta^{18}\text{O}$ values at the shell edge, indicating a warming trend, a spring collection can reasonably be inferred.

Further research

The broad aims and specific objectives of this project are ambitious and it will probably not be possible for everything to be investigated, given the sheer quantity of material that exists and the time and resources available. There is a need for further analysis of material and data from the Grotta dell'Uzzo to be carried out before any firm suggestions can be made about the past seasonal patterns of shellfish exploitation at that site. In particular, the stable-isotope database will be expanded considerably by incorporating the unpublished results obtained by Margaret Deith, who analyzed a large collection of shells from the Grotta dell'Uzzo at the Godwin Laboratory (University of Cambridge) in the early 1980s. Work is also under way on material from several other archaeological sites in the region, including the Addaura and Nissemi caves (Fig. 1), where there are well known rock engravings. We are also continuing the ecological studies at the two localities selected for the monthly surveys, and also at selected localities across the western Mediterranean part of the present range of the targeted species, *Monodonta turbinata*. AMS radiocarbon dating of shells from the Grotta dell'Uzzo is under way, and shells from other sites will be submitted for a further 14 AMS radiocarbon dates, which will make a substantial contribution to the developing chronological framework for Sicilian prehistory.⁹

Notes

1. The ratios of stable isotopes of nitrogen (expressed as $\delta^{15}\text{N}$) and carbon ($\delta^{13}\text{C}$) vary between organisms in marine and terrestrial environments and, therefore, between terrestrial and marine food webs in which humans are consumers (as herbivores, carnivores or both). The variations in these isotopic ratios are complex and not always well understood, but at least in temperate regions $\delta^{13}\text{C}$ in marine food webs is generally significantly lower than in terrestrial ones, whereas $\delta^{15}\text{N}$ tends to be enriched in marine food chains, especially in animals (such as seals and, potentially, humans) that feed higher up those food chains. Analysis of $\delta^{15}\text{N}$ and $\delta^{13}\text{C}$ in bone collagen from ancient human remains can therefore provide an indication of the proportion of marine and terrestrial foods in the diet of

the individuals examined. For further information see references in *n.* 2 below and also J. Sealy, "Body tissue chemistry and palaeodiet", in *Handbook of archaeological sciences*, D. R. Brothwell & A. M. Pollard (eds), 269–79 (Chichester: John Wiley, 2001).

2. M. P. Richards & R. E. M. Hedges: "Stable isotope evidence for similarities in the types of marine foods used by Late Mesolithic humans at sites along the Atlantic coast of Europe", *Journal of Archaeological Science* **26**, 717–22, 1999; "A Neolithic revolution? New evidence of diet in the British Neolithic", *Antiquity* **73**, 891–7, 1999.

3. The Culverwell research project was briefly described by us on pp. 17–19 in *AI 1998/99*. For fuller descriptions and discussion of the evidence, see M. A. Mannino & K. D. Thomas: "Intensive Mesolithic exploitation of coastal resources? Evidence from a shell deposit on the Isle of Portland (southern England) for the impact of human foraging on populations of intertidal rocky shore molluscs", *Journal of Archaeological Science* **28**, 1101–114, 2001; "Depletion of a resource? The impact of prehistoric human foraging on intertidal mollusc communities and its significance for human settlement, mobility and dispersal", *World Archaeology* **33**, 452–74, 2002; and M. A. Mannino, B. F. Spiro, K. D. Thomas, "Sampling shells for seasonality: oxygen isotope analysis on shell carbonates of the intertidal gastropod *Monodonta lineata* (da Costa) from populations across its modern range and from a Mesolithic site in southern Britain", *Journal of Archaeological Science* **30**, 667–79, 2003.

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8. M. R. Deith & N. J. Shackleton (1988: *n.* 5 above); G. Schifano & P. Censi, "Oxygen isotope composition and rate of growth of *Patella coerulea*, *Monodonta turbinata* and *M. articulata* shells from the western coast of Sicily", *Palaeogeography, Palaeoclimatology, Palaeoecology* **42**, 305–311, 1983.

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