3.12 Mesolithic middens and marine molluscs, procurement and consumption of shellfish at the site of Sand | Nicky Milner

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3.12.1 Introduction

Shell middens on the western coast of Scotland were first investigated in the 19th century and since then many have been found both through scientific exploration and by accident. The island of Oronsay is famous for its large mounded shell middens and these have been the subject of several investigations (for example Anderson 1898; Mellars 1987). Similarly, a midden site was found on Risga in the early 1900s and recently has been excavated again (Pollard *et al* 1996). The Oban area is also well known for cave sites with midden deposits, such as MacArthur Cave, the Druimvargie rockshelter, and Carding Mill Bay (Connock *et al* 1992; Pollard 1990). Nearby, on the Isle of Ulva, off the island of Mull, another cave site was found with a Mesolithic shell midden intact (Russell *et al* 1995). The work of the Scotland's First Settlers project has led to the discovery of many more sites including shell middens around the Inner Sound (Hardy & Wickham-Jones 2002).

Despite these many investigations there have been very few published analyses of the shell material from the middens. Ulva is a notable exception and the examination of the shells from this site has resulted in a better understanding of the way in which the people of the Mesolithic procured shellfish, their shellfish exploitation patterns, the processing methods used and the palaeoenvironment (Russell *et al* 1995). Some analysis has also been carried out on the shellfish found in the 1970s excavations in the Oronsay middens, providing information on the procurement methods and palaeo-environment (Andrews *et al* 1985; Mellars 1978). Similar studies have been made on other assemblages from middens in the area but of later date, such as the late Medieval shell midden at Ellary Boulder Cave (Tolan-Smith 2001).

This paper presents the results of shellfish analysis for the site of Sand in Applecross. The shell material was initially sorted by students at the University of Edinburgh and later transported to the University of Newcastle where they were further sorted, counted and measured, following methodologies used at Oronsay (Andrews *et al* 1985; Mellars 1978), Ulva (Russell *et al* 1995) and Ferriter's Cove, Ireland (Woodman *et al* 1999). The counts provide information on the relative abundance of different species. Measurements were made on the three dominant species (limpets, periwinkles and dogwhelks) in order to examine the morphology of the shell, which in turn can reveal something about the environment and the types of shore on which the shells were collected. In addition, these measurements can be used to look for changing size through time, which might indicate changing environmental conditions or pressure, possibly human, on the natural resources. It is important to place the results into the wider context of Mesolithic economy and environment on the western coast of Scotland and therefore these results will be compared with those from other sites, where relevant.

Illus 490: Measuring periwinkles on the beach

In addition, on a visit to the site of Sand in October 2003, the beach was visited at low tide and a modern comparative collection of live limpet, dogwhelk and periwinkle was gathered and measured (see Illustration 490, right). At low tide on this beach a ridge of rock, covered in shellfish, is exposed. The limpets were gathered from both the upper shore and lower shore to examine the well documented variations in morphology across these zones. It was not possible to gather limpets from the middle shore, as has been done in some other studies, because there were no rocks, and therefore no limpets, in this zone. Dogwhelks were also gathered from both zones. Periwinkles were only found in the lower shore area.

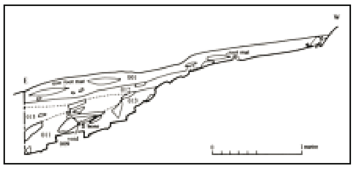
The paper is broken down into sections which firstly deal with the analyses undertaken, followed by a discussion: sampling methods; species found and quantification; measurement results for the three main species; discussion of the results. There are two explicit aims to this paper. The first is to review critically the methods used in order to provide a model for future molluscan studies of similar middens. The second is to use some of the results to reconstruct the ways in which the Mesolithic inhabitants of Sand may have procured and consumed the shellfish.

3.12.2 Sampling

Illus 342: Sand – Trench A,

When carrying out shellfish analysis, it is usually necessary to sample any shell midden unless it is very small, simply because of the vast quantities of shells which are usually present: in the Danish midden of Norsminde it was estimated that there were 83,000 shells within one cubic metre (Bailey & Milner in press). For the site of Sand, square B25B in Trench B was selected as a representative sample for analysis south-facing section showing tail off of midden downslope

(it was later found that, due to recording problems in this area, material from two separate metre squares, B24B and B25B, had been lumped together and therefore B25B represents two metre squares rather than one). This was the central area where the midden was thicker and several contexts were recognisable within the stratigraphy (but see below). In addition, squares A1B to A6B in Trench A were analysed in order to provide a comparison. These squares are close to the edge of the shell midden and stretched for six metres downhill. There was less shell material here, especially further down the slope (Section 3.2). The squares at the top (A1B and A2B) consisted of what appeared to be slumped material derived from the midden upslope (see Illustration 342, upper right). In all areas, although contexts were identified, the squares were excavated in spits and these were divided into quadrants (NE, SE, SW, NW).



Illus 351: Sand – Trench B, north-facing section relating to B25B

Illus 350: Sand – Trench B, Area B1 from the south-west

Below the topsoil (the shell from which was not included in the analysis) in square B25B three contexts were visible (see Illustration 351, above lower right; The midden deposits had little obvious stratigraphical variation, but a layer of crushed shell is visible at top to the east). At the top of the midden there was a layer of crushed shell (12) about 0.05m deep running over the midden deposits. The bulk of the midden was made up of a dense mass of unconsolidated shell (13) which during excavation was noted to be made up mainly of intact limpet shells. Towards the south eastern part of area B1 was a lower layer of shells of a darker grey and ashy consistency (11) which rose up towards the north and comprised the only evidence of stratigraphical variation within this part of the shell midden (see Illustration 350, left). Unfortunately, due to the recording problems mentioned above, it has been necessary to treat all B25B material below Context 12 as undifferentiated midden (which will be referred to as 11/13), though variation was clearly visible in section.

The six grid squares A1B to A6B were fully excavated to bedrock (see Illustration 342, above upper right). A shell-mixed topsoil (1/2) lay across the A trench (although it only appears to be present for squares A1B and A2B in the boxes of excavated material). Below this, in the NW and SW quadrants of A1B and A2B, was a wedge-shaped deposit of shell midden material (28) which appeared to represent slump from the sloping front edge of the midden. This slump overlay organic rich deposits (22) which had comparatively little shell content. Below this lay a sterile palaeosol layer (25) (although a few shells are assigned to this context). Overlying the midden deposits was a slumped stony deposit (27) which separated the midden from sandy soils containing a high percentage of small and fragmented heat affected stones (29 and 17). These layers have been interpreted as slopewash and extended for about 2.5m down slope where the stones had built up against some large boulders.

All of the midden material was initially sorted at Edinburgh University by undergraduate students, and this included sorting out the shell material into different species and shell residue. The shell material from the selected squares was then transported to Newcastle University and the rest of the analysis (measuring and counting) was carried out by students in the Archaeology Wolfson Laboratory. Initially it was intended that the whole of B25B would be analysed; but in the end lack of resources meant that this was not possible and so it was sampled. About three quarters was analysed, see Table 167, below. All of the six squares in Trench A were analysed, because there was far less material from this area.

Table 167

Sand 2000 B25B spit	context	NE	NW	SE	SW
2	12	X – spit not divided into quadrants			
3	13/11	X		X	X
4	13/11	X	X		X
5	13/11		X	X	X
6	11/13			X	X
7	11/13	X	X	X	X
8	11/13	X	X	X	
9	11/13	X		X	

Table 167: Sand, B25B, marine molluscs – quadrants analysed

3.12.3 Species found within each midden area

The shells from both areas were sorted according to species. Then, in order to examine the relative abundance of the different species within the different areas and contexts of the midden, the species have to be quantified. This can be achieved by using either MNI (minimum number of individuals), NISP (number of identifiable specimens) or by weight. MNI is usually the preferred method of quantification in this kind of context; the theoretical problems related to using MNI analysis on archaeozoological assemblages not being applicable to invertebrate remains (Claassen 1998:106). Weighing the shells is a speedier method but the key problems are that there can be differentiated loss of weight due to diagenesis and heavier shelled species are disproportionately represented (Claassen 1998:107). Russell *et al* (1995:Table 4) use both MNI and weight and show some correspondence between the two methods. However, weighing and calculating MNIs were used for the test pits found in the Scotland's First Settlers survey and it was found that there was a discrepancy between weights and MNI particularly with dogwhelks (Section 2.2). The reasons appear to be the heavier weights of the dogwhelks and taphonomic issues. Woodman *et al* (1999:94), in the analysis of molluscan remains from the Mesolithic site of

Ferriter's Cove, Ireland, also found problems with weighing the samples because of the sediment inside the gastropods which could not be removed. The quantification of MNI is thus the method which has been used for Sand (Claassen 1998).

The MNI is calculated by counting the apices for the gastropods, and the umbones of the bivalves are sorted into umbilici (left and right halves) and counted; the largest sum is then used as the MNI, for example where there are 50 left umbilici and 30 right umbilici the count for the left umbilici would be used. The counts were recorded by spit and quadrant and the raw data can be found in Appendices 14 & 15. In order to interpret this data the MNIs have been summed by context and these results will be discussed below.

For some species it is not possible to count the MNI; razor shells were found in some parts of the midden but, due to their fragmentary condition and lack of apex or easily identifiable umbone, their presence was simply noted.

It was found occasionally that some apices were not in the sorted limpet bags, but were still in the residue bags and had been overlooked during initial sorting. In this case, if there appeared to be many in the residue bags, they were spread out again and quickly scanned. Apart from the other possible problems in assessing MNI this suggests that the MNI for the limpets in particular will be fairly crude. However, as the limpets are by far the most predominant species in most contexts and as usually less than 200 apices had been missed, compared with several thousand in total, the relative frequencies of species should not be greatly affected. In the case of Trench A all the residues were re-scanned and the MNIs corrected accordingly.

Before describing the species found and calculating the MNIs, it is important to add a caveat. Shell, like any archaeological deposit, is subject to taphonomic processes (Claassen 1998). Dissolution and chemical conversion are usually the main processes within a midden and the shell will be subject to more complex sequences of taphonomic processes if exposed to either salt or fresh water as opposed to dry deposits. Shells can, for instance, be dissolved in terrestrial settings by the carbonic acid in acid rain or nitric acids from organic decay in the soil. The rate at which the shell is dissolved depends on many factors including the acidity of the ground water, duration of exposure to the acids and skeletal porosity of the shell. Chemical conversion may also occur but this varies depending on the levels of magnesium, aragonite and calcite in the shell.

Other cultural factors will affect the shell, such as heating which can alter the crystallography and internal structure of the shell, hence burnt shells may fracture more easily (and weigh less). Walking across the shell midden or dumping more shells and other material on it will result in breakage which can vary by species. It must also be remembered that the midden probably does not represent the complete assemblage of shellfish (and other animals) gathered during the times of human activity: it is probable that some shellfish were processed and eaten on the shore or taken elsewhere and the midden may represent a sub-sample of shellfish used at this location.

Perhaps one of the most critical points to make when quantifying shell is that differential preservation appears to occur in the middens, that is some species decay more rapidly than others. In the case of Sand, gastropods like the periwinkle and dogwhelk are comparatively robust, and often appear as whole specimens, while the structure of the shell continues to appear tough. Other species, mussel in particular, are often found in a very fragmentary state. Mussel shell is sometimes so degraded that pieces of shell can literally be turned to dust if rubbed between two fingers. This species in particular is thus likely to be substantially under-represented on many sites, including Sand.

To sum up, it is important to note that there are always intrinsic difficulties with sampling and quantification methodologies for shell as well as the inherent taphonomic biases. When considering the results it is necessary to take these problems into account: inevitably there will be a margin of error and the results in terms of percentages of shells should not be regarded as definitive but as a guide to the relative proportions of some species.

3.12.3.1 Description of species

Illus 491: The difference between the smooth and the ribbed limpets

The following descriptions of species identified are taken from Barrett & Yonge (1958), Brehaut (1982) and Gibson *et al* (2001). The most abundant species present was the limpet, *Patella* sp. There are two species which could be present on these shores: *P vulgata* and *P aspera*. It is difficult to distinguish between the two without the animal inside or the colouring inside the shell, which archaeological specimens do not have. When the limpets were being sorted it was noted that there appeared to be two types. One group has pronounced ribs and a jagged aperture, whereas the second group has a smooth exterior and a smoother aperture; but it was not clear whether this variation indicated that they represented different species, (see Illustration 491, right). A comparison of the measurements of the limpets was made but there was no significant difference in size. In order to obtain a second opinion on this matter a sample of these limpets was sent to Janice Light (freelance consultant). She confirmed that they were probably all *Patella vulgata*, with the exception of perhaps one which could be Patella aspera, because it had secondary riblets between the main ones. It is concluded that the majority of specimens in the midden are probably the most common species, *Patella vulgata*, but it may also be possible that there are also some *Patella aspera*.

Limpets are highly subject to morphological convergence and the observable differences of smooth and ribbed are probably features of the shell which characterise their living environments. It is possible that the shells were coming from different levels on the shore, or from different areas of exposure/shelter, or from different sites. For the Sand assemblage it is possible to rule out different locations on the shoreline because there was no difference in the measurements between the two groups. Therefore, it is likely to be related to gathering from different locations. Certainly, on visiting the beach at Sand and examining the modern shells, there was no sign of the smooth version of the shell and only the ribbed limpets were found. In future projects, during excavation, it would be interesting to look out for such variations in shell morphology within the midden deposits because if they are found in localised areas it may be that they are being collected from different zones.

In terms of gathering, limpets cling tightly to rocks on the high, middle and low rocky shores in large numbers and they are fairly easy to exploit after a little experience; they simply need to be knocked off the rocks with a stone (and see Birch, Section 3.4). They can be used either as bait or directly as food. This will be explored in detail in the discussion.

The periwinkle, *Littorina* sp was also fairly common on the site. These tend to be found on rocky shores or stones. There are several different species of periwinkle but the ones found here are *L littorea*, the common or edible periwinkle, and *L littoralis*, the flat periwinkle. Identifying other species from an archaeological sample can be difficult because, as with the limpets, they have lost their colour. Because of this it is possible that there may be a small sample of other species: at Ulva cave L saxatilis and a possible mariae were also identified (Russell *et al* 1995).

The common or edible periwinkle is the larger of the two and lives on rocks and weed on the middle shore and below. The flat periwinkle is much smaller and is flat-topped, usually colourful (yellow, red, green and so on) and is more likely to be collected because of its aesthetic qualities or because it is attached to weed, rather than for consumption purposes (see Illustration 492, right). It lives on the middle and top shore, especially on the Fucus weed. Periwinkles are easy to pick off the rocks and they congregate in large numbers.

Illus 492: Topshells (left) and colourful periwinkles (right) from the beach

The other fairly dominant species is the dogwhelk, *Nucella lapillus*. This species is a carnivore and is a predator of barnacles, limpets, mussels and other molluscs. They are found on rocks in fairly large numbers. Like periwinkles they are very easy to pick off the rocks. On the modern shore at Sand they were found on the middle and high shore and generally not in the same location as the periwinkles. They tend not to be regarded as good to eat and sometimes their presence on an archaeological site has been attributed to collection for dye because they secrete a substance which can be used as purple colouring, (Gibbons & Gibbons 2004) however, very large numbers would be needed for this (see discussion below).

One other gastropod has been found on the site: the topshell, *Gibbula* sp. There are many species of topshell and they are distinctive if worn because they often reveal mother-of-pearl layers. The few shells that have been found here look to be *Gibbula cineraria*, the grey top shell. These are herbivores, they live on rock or weed and are found on the middle and lower shores. They can be consumed but they may also have been collected for their aesthetic qualities (see Illustration 492, above right).

Several bivalves were also found on the site. The mussel, *Mytilus edulis*, is a very common shore animal found in dense beds on rocky, stony and muddy beaches on the middle shore and below, attaching itself to rocks by means of byssus threads. It can easily be gathered by pulling it off the rock and many can be collected because they occur in groups in abundance as noted above. The mussel, however, does not usually survive well on archaeological sites and is often powdery and much degraded. It is likely that on many archaeological sites where mussel is identified it will be significantly under-represented.

The cockle, *Cardium edule*, is harder to exploit because it burrows superficially in sand or mud and therefore needs to be dug or raked out. It tends to be found on the middle and lower shore in great numbers, forming dense cockle beds. Like the mussel, it is widely collected for food today.

The scallop, *Pecten maximus*, is an offshore species. Usually this species only occurs in small numbers on a site. They provide good meat and may have been consumed, but the shells may also have been collected because the large flat valves are good raw material for tools (see Section 3.5). They make good 'plates' and the lower convex valves make good containers. There are several scallop fragments throughout the midden at Sand and one does appear to have been deliberately cut. Scallops that have been collected empty and worked have been found at other sites, for example Oronsay and Ulva (Mellars 1987; Russell *et al* 1995).

The carpet shell, sometimes termed a clam, belongs to the Veneridae family. It is hard to be sure of the species found at Sand because they are represented by a few fragmented pieces. Some fragments of razor shell, *Ensis* sp, have also been found. The razor shell is highly characteristic, up to eight times as long as broad. This mollusc is found on sandy shores but they are not easy to gather because they burrow so deeply and can move so rapidly through the sand, but again the shells can often be found washed up on the shore and the sharp edges may have been used in some way. It is worth noting that in many parts of Britain today they are considered an edible delicacy and collection is a specialised process.

In addition, a number of minute species, no larger than about 5mm were found. These have not been identified to species or quantified. They are unlikely to have been gathered intentionally but were either transported to the site on seaweed, where many of them live, or collected along with some of the other larger species.

One species which appears to be 'missing' from this assemblage is the oyster, *Ostrea edulis*. This is perhaps surprising because most other similar assemblages include some oysters, even if in extremely small numbers (Russell *et al* 1995; Tolan-Smith 2001; Mellars 1987). They may not have been sought after; on the other hand, the majority of species recovered from Sand are rocky shore dwelling species and it may well have been that oysters, which tend to be submerged and attached to a firm substrate, were not available here.

3.12.3.2 Relative proportions of species

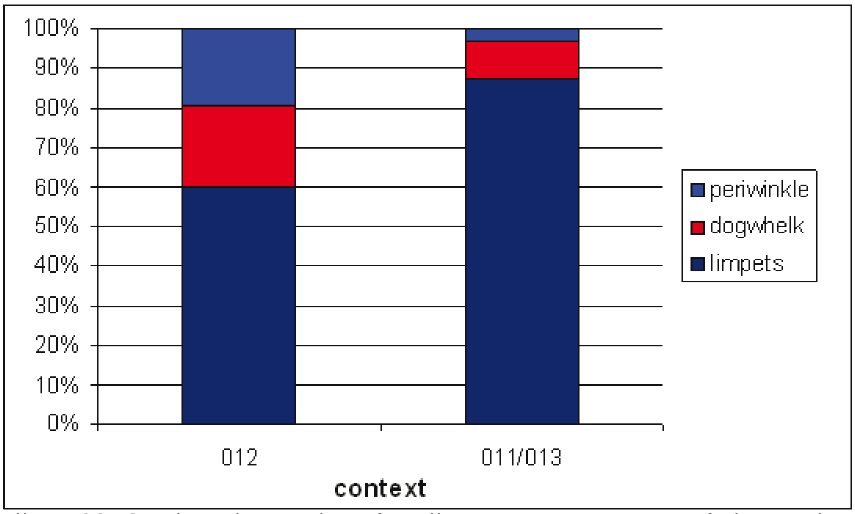
B25B

Eight species have been identified, Table 168 (below). The quantities of the three dominant species (limpet, dogwhelk and edible periwinkle) can be compared in a bar chart (see Illustration 493, below). The dominant species is the limpet, with dogwhelk second and periwinkle third. In Context 12, the top layer, the percentage of limpet to other species is lower (60%), with almost equal proportions of dogwhelk and periwinkle but in the main midden below this limpet constitutes over 85% of the sample. Mussel constitutes about 1% of the assemblage in each context. However, as already mentioned, a taphonomic bias is likely to mean that there were originally a greater number of mussels in all contexts.

Table 168

Sand 2000 B25B context	limpet	dogwhelk	periwinkle	mussel	flat periwinkle	clam/scallop	topshell	cockles	total MNI
12	1028	358	331	17	3	1		2	1740
13/11	32881	3521	1192	367	21	1	6		37989

Table 168: Table to show MNI for each species per context in square B25B



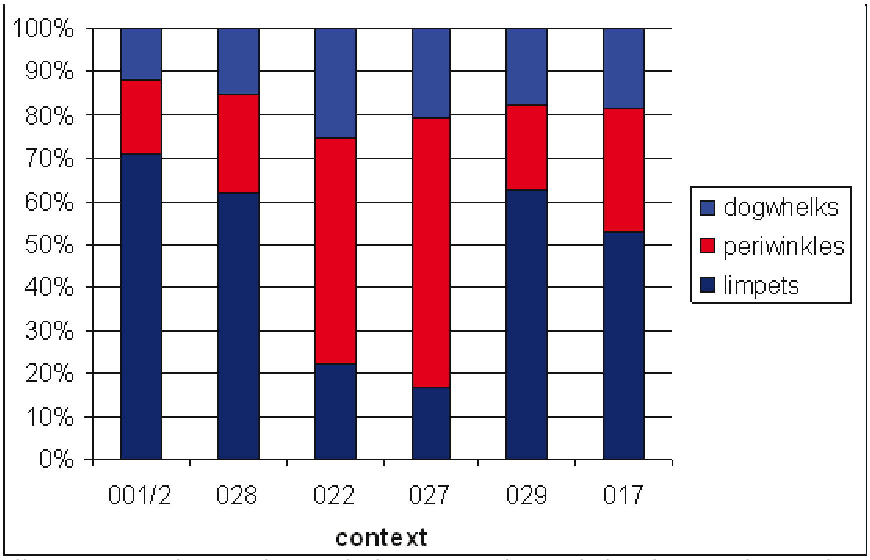
Illus 493: Sand, main species of mollusc as a percentage of the total MNI of those species, per context

Trench A

Table 169

Sand 2000 Trench A Context	limpet	dogwhelk	periwinkle	mussel	flat periwinkle	clam/scallop	cockle	razor	total MNI
1/2	3746	633	916		11		12		5318
28	2471	608	903	3	8		9	x	4002
22	145	167	348	1			1		662
27	17	21	64						102
29	680	192	214	1	1	1		x	1089
17	107	37	58		1		1	x	204
25	2	1							3

Table 169: Sand, MNI and presence of species in Trench A



Illus 494: Sand, Trench A, relative proportions of the three main species as a percentage of the total number of shells per context (25 has been excluded because the total MNI is so small)

Eight species have been identified in Trench A. The MNIs of seven of these species can be seen in Table 169 (above) and the presence of razor shell is denoted by an x. These results are presented as a chart in Illustration 494 (above).

Shells from 1/2 (shell mixed topsoil) were analysed from A1B and A2B. It can be seen from Illustration 494 (above) that the limpet was the dominant component of this context, followed by periwinkles and dogwhelks. Mussels, flat periwinkles and cockles were also present in much smaller quantities. In the slump at the front slope of the midden (28) the composition of shell species is very similar to the shell-mixed topsoil (see Illustration 494, above) that is mainly limpets, followed by periwinkles and dogwhelks and small numbers of mussels, flat periwinkles and cockles. There was also a significant quantity of razor shell from this context.

Context 28 overlay organic rich deposits (22) which had comparatively little shell content. Here, the dominant species is periwinkle. The slumped stony deposit (27) had even less shell material but, like 22, has a predominance of periwinkles. The sandy soils above the midden (17, 29) contain a relatively small number of shells with limpet as the dominant species followed by periwinkles and dogwhelks but very few other species, although razor shell does appear to be present in both contexts. Although these layers contain a lot of stones that had been heat affected there is no visible signs of heating or burning on the shells. Further down slope there was no midden (squares A5B and A6B) and no shells, though three shells were found in 25 (A6B), probably having fallen down slope (consequently this has not been represented graphically).

3.12.3.3 Comparison of trenches A & B

It is estimated that there are about 50,000 shells within the two squares B25B. In A1B there are approximately 8,500, A2B – 2000 and in the rest of the trench less than 700. It is difficult to estimate how many molluscs must have been gathered in total for the whole midden but, if the squares around B25B are similar in size and then tail off as they do in Trench A, then a very rough approximation would be anything between 150,000 and 300,000 shells.

There appears to be some degree of homogeneity throughout the midden: limpets tend to predominate, with the exception of Contexts 22 and 27 in Trench A. Periwinkles and dogwhelks can also be regarded as key species throughout. However, there are some subtle differences and the two areas are fairly different in terms of proportions of species and, in some cases, types of mollusc.

Mussels are more common in B25B than in Trench A. It is possible that this is due to taphonomic processes but there is no obvious reason why there would be a variation in preservation between two midden areas which are so close to each other. Topshell is only a minor species and occurs in very small numbers but it too only occurs in B25B. Conversely, razor shell is present in Trench A but does not appear in B25B.

In terms of relative proportions of species there is a greater amount of limpet in B25B, where limpets constitute almost 90% of the material in the main midden 13/11. In Trench A, however, there is no more than 70% limpet in any context and, if the topsoil (1/2) is not included, then limpet only accounts for 50–60% of the shell material in Contexts 28, 29 and 17. The contexts at the base of the midden, 22 and 27, are interesting in that they contain a majority of periwinkles.

In summary, the differences in shell content between the two areas are very probably significant. Trench A is thought to represent tipping from further upslope, that is in the vicinity of B25B. It is likely that the deposits in Trench A are slightly later stratigraphically and perhaps even came from above the contexts now in B25B. The observed differences may represent subtly different gathering strategies through time. These differences can be investigated further by taking measurements of the shells.

3.12.4 Limpet size and morphology

The measurements of limpets can be compared between contexts in order to determine whether there is any change in size through time. This phenomenon is often used to determine the intensification of human predation or a change in the ambient environment or climate (for example Bailey & Craighead 2003; Mannino & Thomas 2001 & 2002; Milner 2004a). To understand fully which of these factors may have played a part in a change of size it is important to have some age information as well as size measurements (Claassen 1998:45). Without this it is impossible to say whether a sample which appears to be smaller is simply younger, the average age being pushed down through exploitation of older specimens, or whether changing conditions mean a reduction in growth. In the present study it has not been possible to age the molluscs. Nevertheless, a preliminary investigation of size has been conducted in order to make a comparison between contexts.

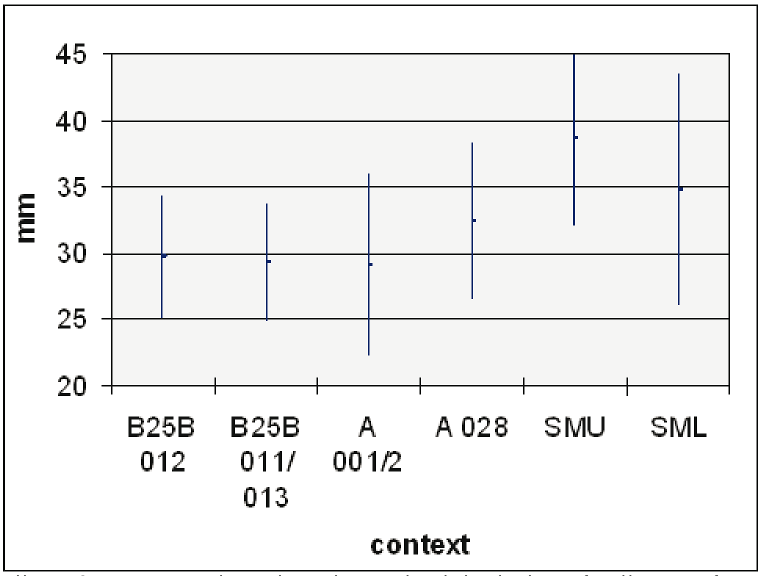
The morphology of the shell may also be assessed. Although they move around whilst feeding, limpets do not move between zones along the shore and the shape of the shell is partly determined by the position on the shore. Limpets living near the high tide mark (upper shore) have taller, more conical shells, whilst those at the low tide mark (lower shore) have much flatter shells. This is related to the force with which the limpet attaches itself to the rock and the amount of time it is out of water. When out of the water the muscles contract keeping the limpet firmly attached to the rock which reduces water loss. This pulls in the mantle which secretes the shell thus affecting shell shape. Therefore by calculating the ratio of length to height of the shell and comparing with modern shell morphology, the gathering strategy of the shell collectors may be assessed (see for example Mellars 1978; Russell *et al* 1995).

In this study, measurements were taken on the complete limpets to 0.1mm using electronic calipers. The length (L1) is taken across the longest length and the height (L2) is measured from the apex to the base of the shell. It must be remembered that many of the limpets in the midden were fragmentary and therefore the number of complete limpets is significantly smaller than the MNI per context. Sampling was not employed and, in most cases, all limpets that could be measured were measured. In Trench A there were very few measurable limpets in some of the contexts and therefore these contexts have been excluded because the sample size is too small. Results from 1/2 and 28 will be used. A good sample size was also obtained from B25B. The measurements of all limpets can be found in Appendix 16.

This section will be divided into two parts. Firstly the lengths of the limpets will be compared between contexts, and secondly the morphology of the limpets will be assessed.

3.12.4.1 Comparison of average length

When the average lengths and standard deviations are compared, the results seem to demonstrate some similarity in size between contexts, although the mean of Context 28 is slightly greater than the other means (see Illustration 495, below). Interestingly the modern limpets are on average larger than the archaeological samples, particularly those from higher up on the shore. These observations can be tested further using analysis of variance to see whether the differences are significant, that is that the differences between groups are due to some systematic influence and are not due to chance. ANOVA multiple comparisons calculated using SPSS actually show a significant difference at the 0.05 level between several of the contexts (Appendix 19). The modern controls are different to all of the archaeological contexts (with the exception of the lower shore limpets and 28), and to each other.



Illus 495: average length and standard deviations for limpets from Sand
SMU= Sand modern upper shore (N=50), SML= Sand modern lower shore (N=51),
12 (N=391), 11/13 (N=11749), 1/2 (N=82), 28 (N=72)

Problems arise, however, when trying to interpret these differences. There can be many reasons for changes in shell growth and Claassen (1998:113) believes that there is no way of differentiating between influences such as impacts of recruitment, predation-mortality, discard behaviour and sampling. This has been debated (for example Mannino & Thomas 2002) but in the case of Sand the changes in sizes observed are unlikely to be meaningful. The larger modern limpets may be larger because they are not currently gathered by humans, but there may also be some environmental explanation; the ambient environment no doubt having changed in many ways since the Mesolithic.

Relatively speaking, the midden at Sand is very small, compared for instance to the Danish kitchen middens where a change in size through the vertical stratigraphy could feasibly be hypothesised to be a result of human predation. In the case of the smaller limpet middens of the west coast of Scotland it is difficult to say how intensive the pressure of gathering would have to be to actually create an observable change in size. The fact that there is no dramatic change here between 12 and 11/13 may suggest that limpet gathering was a sporadic activity carried out on a small scale but there is a lack of stratigraphy which means that it is very difficult to test. Although there could be 150,000 shells within the midden, steady collection of about 300 limpets a day for a period of a month every year would quickly build up a midden the size of Sand within a generation of about 16 years. The collection of 100 modern limpets on the beach appeared to be a very small percentage of the overall population today. Without any data on the Mesolithic natural population, without data on limpet recruitment and without knowing how far afield people were gathering limpets, it is impossible to model how the natural population may have been affected.

3.12.4.2 Morphology

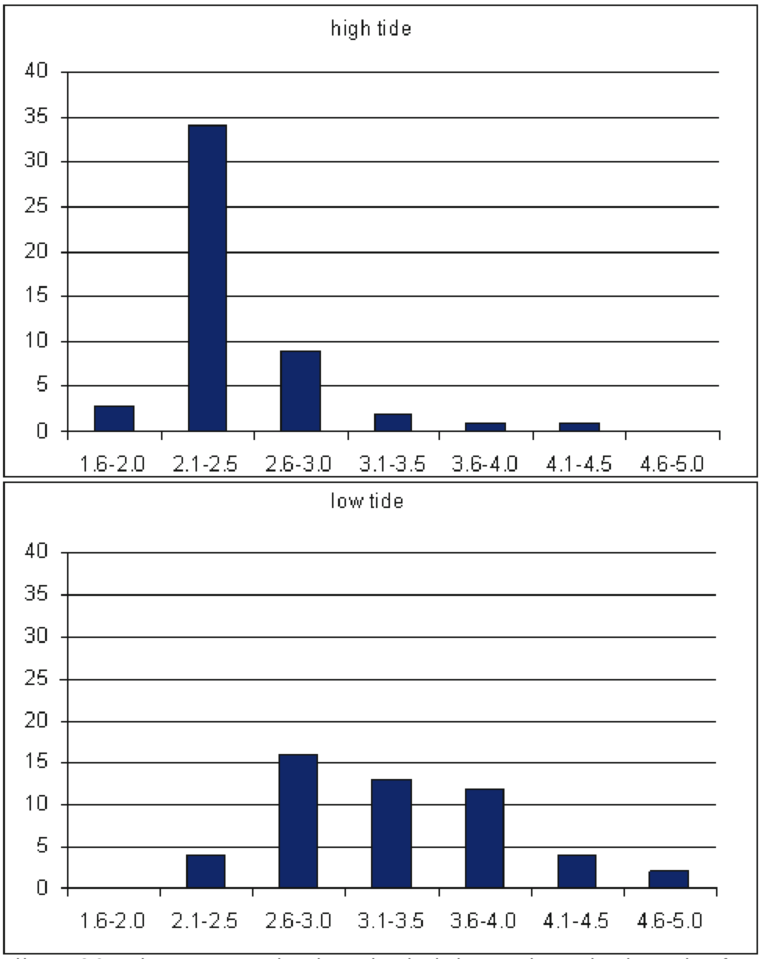
The limpets from B25B and Trench A (the vast majority of measurements are taken from A1B) were measured and the ratio of height to length calculated. In order to make a distinction between the zones of the shore from which limpets may have been gathered it is important to use a modern control so that the variation in shape between upper and lower shore limpets may be properly understood.

Usually histograms are used to present the results of height/length ratios (Mellars 1978:fig 8; Russell *et al* 1995; Tolan-Smith 2001:Illus 61). However, it is possible that this representation can skew the data because the ratios obtained are placed into arbitrary groupings rather than considered as individual points. This is a fundamental problem because it directly affects interpretation. To illustrate this point the data from the modern controls and an archaeological sample will be presented in histogram form and then in scattergrams.

As can be seen in Illustration 496 (below), there is a difference in modern limpet morphology between the upper and lower shores. If the archaeological limpets from A1B Context 1/2 are presented in histogram form and compared to the modern controls, it could perhaps be interpreted that they were being harvested mainly from the lower shore (see Illustration 497, below). However, this interpretation changes if a scattergram is used. In Illustration 498 (below), there is a clear difference in morphology between the lower and upper shore limpets, with very few exceptions. When the archaeological limpets from A1/2 are laid over this distribution (see Illustration 499, below) two important points can be observed:

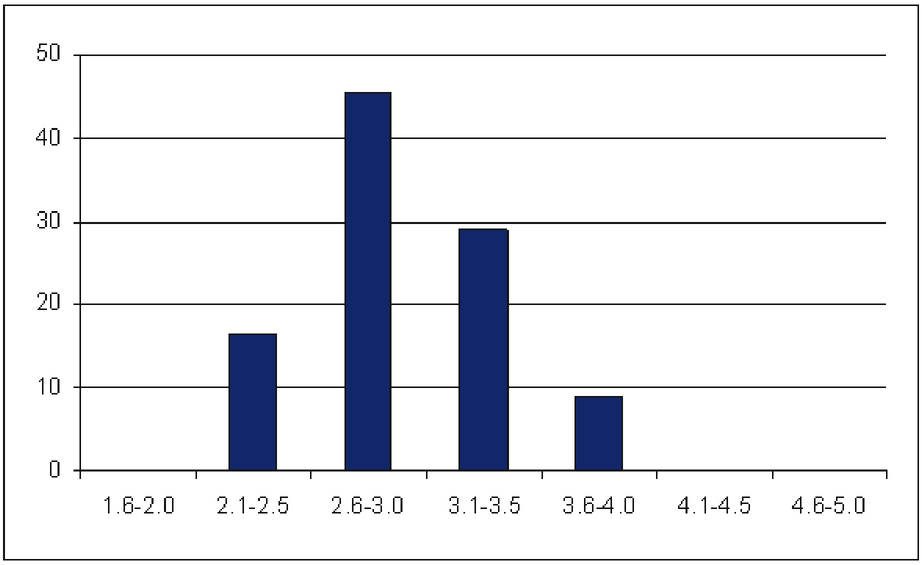
1. the archaeological assemblage is different to the modern controls (as already observed in the ANOVA tests) in that in general the shells are smaller and have a different curve on the graph; the modern controls therefore should not be used as a direct comparison;
2. if an interpretation was to be made from this graph, it is arguable that limpets of various sizes were being collected from both the lower and upper shore. Although the smaller shells look as if they fall into the upper shore zone this is unlikely to be real and more probably due to the differences between the modern and archaeological populations. Skip Charts.

Illustrations 496–499

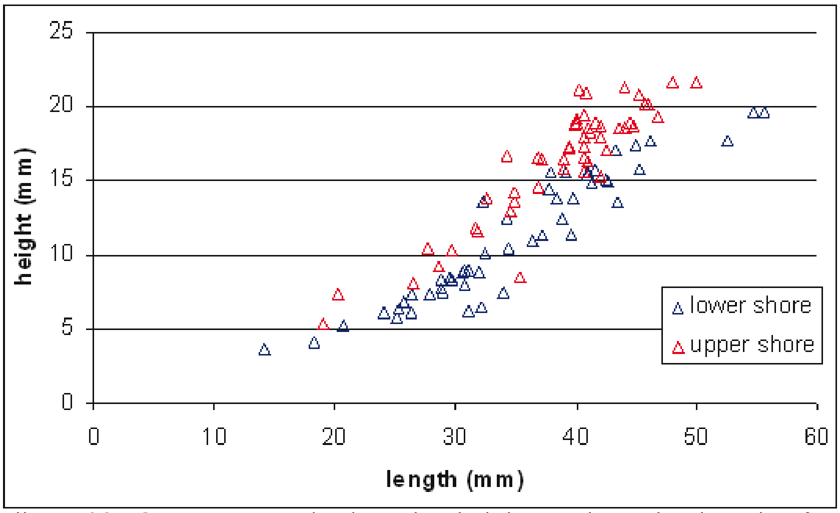


Illus 496: Histograms plotting the height against the length of modern limpets, collected from the lower shore and upper shore

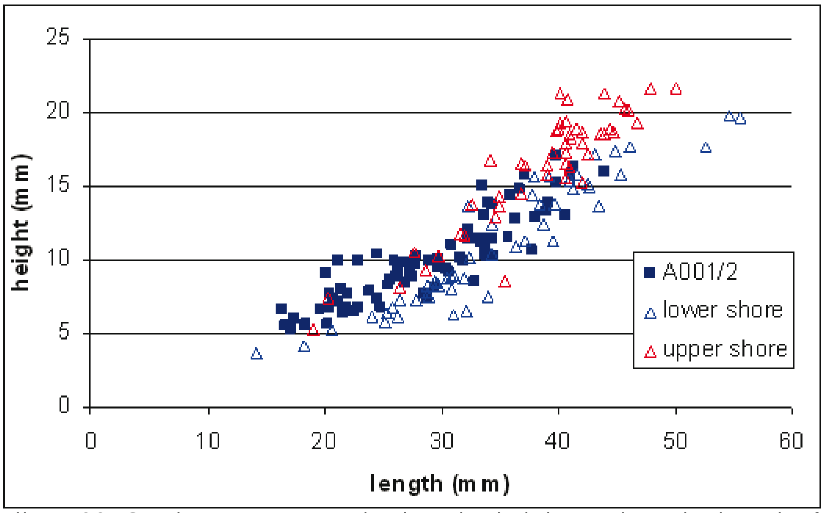
at Sand, October 2003. The groupings are equivalent to those in similar studies (for example Russell *et al* 1995:282)



Illus 497: Sand, histogram plotting the height against the length of limpets from A1B 1/2

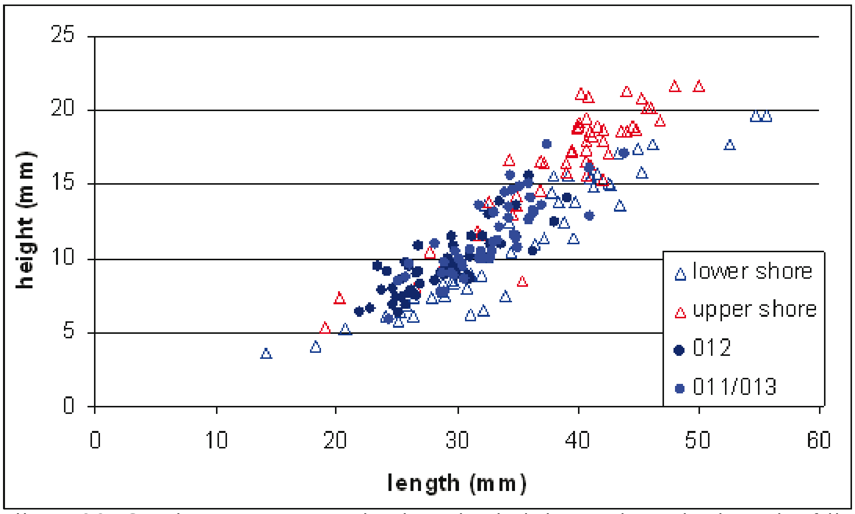


Illus 498: Scattergram plotting the height against the length of modern limpets, collected from the lower shore and upper shore at Sand, October 2003



Illus 499: Sand, scattergram plotting the height against the length of limpets from Trench A, Context 1/2 and this is then overlain by the data from the modern limpets

For each of the contexts in B25B a random sample of 50 limpet measurements has been plotted (see Illustration 500, below). It can be seen that the scatter of modern limpets again falls over the archaeological distribution suggesting that limpets were collected from both shore zones. Again it is difficult to compare the modern limpets with the archaeological ones because the modern ones appear to be much larger.



Illus 500: Sand, scattergram plotting the height against the length of limpets from B25B and measurements from the modern limpets

The results of this analysis show that both tall and squat limpets were being collected, and the likelihood is that collection did not concentrate on one zone of the shore alone. At many of the other archaeological sites which have been examined the results tend to suggest that limpets are gathered from the lower and middle shore, for example at Caisteal nan Gillean, Oronsay (Mellars 1978:387), Ellary Boulder Cave (Tolan-Smith 2001:114) and Ferriter's Cove (Woodman *et al* 1999:99). It is possible, however, that the use of histograms in presenting this type of data can create a false outcome and, in reality, the results may not be so clear cut. It is also important to note that there will be differences in limpet morphology through time and the analysis of modern limpets as an analogue should be used with caution.

3.12.5 Dogwhelk size and morphology

Dogwhelks can be measured like limpets in order to determine whether there is any change in shape or size through the midden. For example, Russell *et al* (1995) found that at Ulva there was an increase in dogwhelk size in the uppermost layer of the midden, but because so few dogwhelks were exploited it was suggested that this change should probably be attributed to ecological factors.

When dogwhelks occur on archaeological sites they also tend to be measured in order to reconstruct the palaeo-environment (for example Andrews *et al* 1985; Russell *et al* 1995). The height of the shell and the height of the aperture are measured and the ratio determined to assess morphology. Elongate shells with narrow apertures tend to be found on sheltered shores and are thought to provide a defence against crabs which are more abundant in these locations. Those dogwhelks found on exposed shores have wider apertures and are squatter. Andrews *et al* (1985) found that the difference in height/aperture ratio between modern and archaeological dogwhelks on Oronsay was perhaps suggestive of increased storminess today. Russell *et al* (1995) also made a comparison of modern dogwhelks with those found in the archaeological midden at Ulva and again found that there was a significant difference; the archaeological shells being more elongate. Again, this may be attributed to increased storminess, though it is also suggested that the changing morphology may be attributed to changing coastal configuration through changing sea-level during the Holocene.

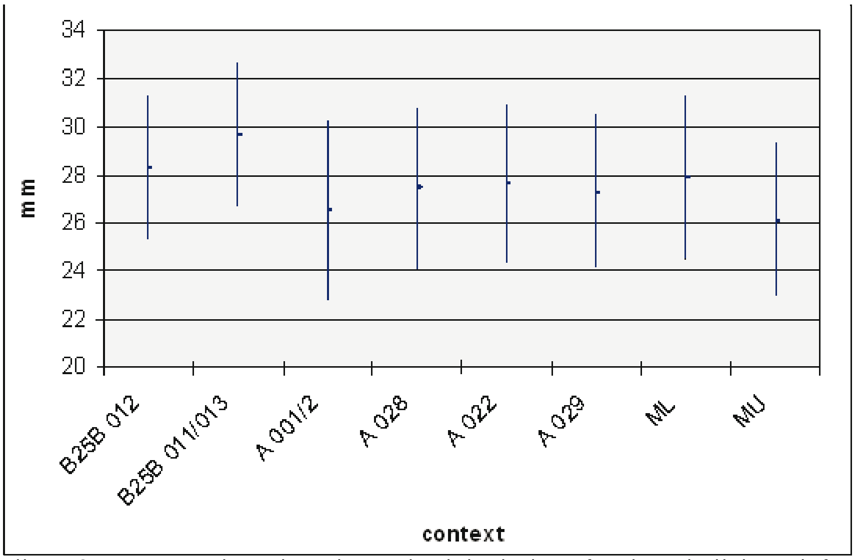
3.12.5.1 Comparison of average length

It can be seen in Illustration 501 (below), that there appears to be a small difference between dogwhelks in B25B and those in Trench A: if the Trench A deposits are later in date this suggests that the dogwhelks are becoming slightly smaller through time. In comparison with Ulva cave, all the dogwhelks from Sand are rather large. The average size for the lower three layers at Ulva was around 25mm, but it increased to almost 29mm in the top layer (Russell *et al* 1995:Table 5).

Again ANOVA tests were made at the 0.05 level and these demonstrated further differences between the contexts within B25B, but no real differences between the Trench A contexts. The modern dogwhelks are shown to be different to the B25B dogwhelks. As with the limpets, it is very difficult to interpret these differences.

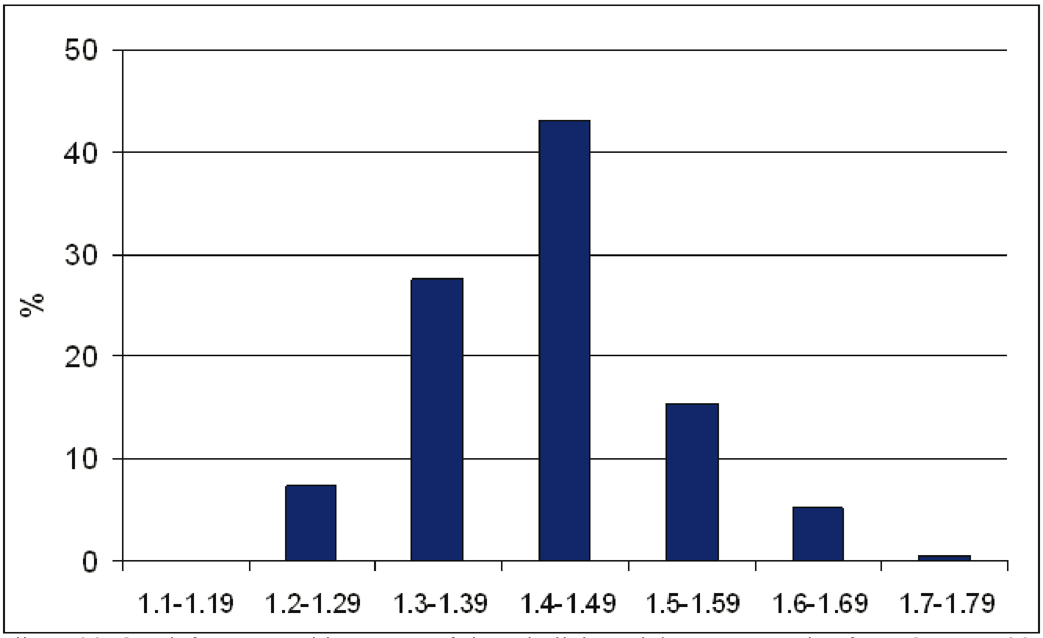
3.12.5.2 Dogwhelk morphology

Despite there appearing to be a difference in size of dogwhelk between the two areas of the midden, there is homogeneity in morphology with the modal class ratio 1.4–1.49 for dogwhelks. Illustration 501 (below) shows the typical distribution of ratios. The dogwhelks from the modern shore are also the same.

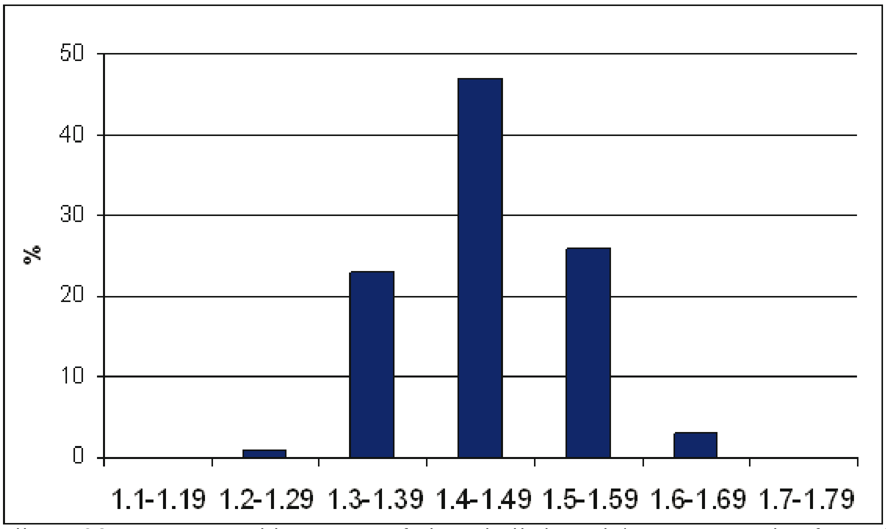


Illus 501: Average length and standard deviations for dogwhelk length from Sand 12 (N=249), 11/13 (N=1333), 1/2 (N=350), 28 (N=326), 22 (N=65), 29 (N=58), ML= modern lower shore (N=50), MU= modern upper shore (N=50).

Compared with the dogwhelks from Oronsay, those from Sand (ancient and modern) are very squat (see Illustrations 502 & 503, below). The mean length/aperture ratio from the sheltered east coast of Oronsay is 1.73 and 1.64 on the exposed west coast (Andrews *et al* 1985). The results from Ellary demonstrated even more elongated shells with a mean of 1.84 (Tolan-Smith 2001:116). The dogwhelks from Sand look to be fairly similar to the archaeological samples from Ulva although those from Ulva may be even slightly squatter (Russell *et al* 1995:Illus 13).



Illus 502: Sand, frequency histogram of dogwhelk length/aperture ratios from Context 28 (N=326).



Illus 503: Frequency histogram of dogwhelk length/aperture ratios from the

collection of modern dogwhelks (N=100) from the beach at Sand.

This data is perhaps surprising considering that the dogwhelk length/aperture ratio is considered to be related to shore exposure: Oronsay is probably more exposed to the elements than Sand or Ulva and yet the dogwhelks there are more elongate suggesting a sheltered shore. However, there are some caveats to the interpretation that the ratio is related to exposed or sheltered shores:

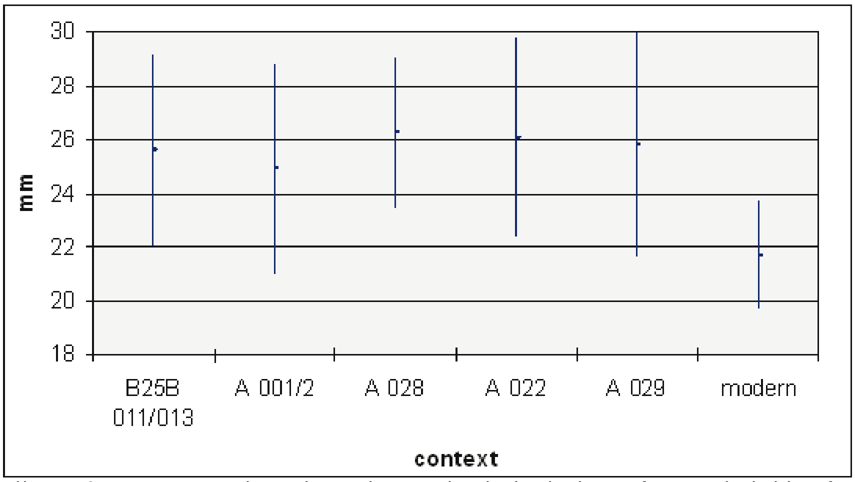
1. the intensity of the predation of crabs will affect the morphology; crab remains have been found at the site but of course the numbers of crabs on the beach in the Mesolithic is unknown (see Milner, Section 3.13) and
2. the genetics which may influence shape are also poorly understood and may apply differently to island populations (Andrews *et al* 1985).

It is thus impossible to offer an interpretation of the morphology of the dogwhelks from Sand.

3.12.6 Periwinkles

The edible periwinkle is fairly robust and survived well in the midden at Sand. Periwinkles were measured simply by taking the height from apex to the bottom of the aperture. Little can be said about the results. As with many other sites there is no variation in size through the midden, (see Illustration 504, below; for example Russell *et al* 1995; Milner 2004a). From the relatively small quantities gathered one would not expect to see any change in size due to exploitation patterns.

There is, however, a significant difference between the archaeological and the modern periwinkles. Unlike the modern limpets that appear to be larger than their archaeological counterparts, the periwinkles are much smaller on the beach today. The reason for this is unknown but it is likely to be due to differences in habitat and environment since the Mesolithic.



Illus 504: Average length and standard deviations for periwinkles from Sand. 11/13 (N=948), 1/2 (N=302), 28 (N=254), 22 (N=105), 29 (N=61), modern (N=50)

3.12.7 Summary and discussion

In summary, the following results can be presented:

- Like other middens in the area, Sand is dominated by limpet, with significant numbers of dogwhelk, periwinkle and mussel.
- There are two contexts in Trench A where periwinkle rather than limpet dominates the assemblage: an organic rich deposit (22) and some stony slumping (27), both of which lie outside of the midden. These may represent a slightly different episode of gathering or consumption, which could be the result of many different things, such as a seasonal change in gathering.
- There are a number of other species present but these occur in much smaller numbers. They may have been consumed (for example possibly the razor shells), or perhaps been gathered for their aesthetic qualities or even accidentally (for example the flat periwinkles) and some may have been used for other purposes, for example scallops as implements. But it is of course possible that consumption and other uses were entwined for some of these species, such as scallops which are both useful and considered good to eat.
- There are some differences between the two areas of the midden, B25B and Trench A: there is more mussel in B25B; limpet constitutes a greater percentage of the assemblage in B25B; topshells are also found here but not in Trench A; and the razor shell is only present in Trench A. Again this suggests some variation in gathering and consumption through time.
- Surprisingly, no oyster has been found in the midden even though it has been found in small numbers in similar (though later) middens elsewhere around the Inner Sound (Section 2.2). The assemblage is a rocky shore assemblage however, and few other bivalves are present either so the lack of oyster may be environmental.
- It is estimated that there are about 50,000 shells within B25B and about 9,000 in Trench A. A very rough estimation would suggest anything between 150,000 and 300,000 shells in the midden overall.
- There are some differences (often very subtle) in the samples of limpets measured but it is impossible to say what has caused them. It is unlikely from a midden of this size that there would be any dramatic decrease in size due to heavy human predation, unless the midden had accumulated very rapidly within a

couple of years and the natural population of limpets had not had time to recover. However, it is more likely that the subtle differences are a result of gathering on different parts of the shore, or due to minor changes in the ambient environment.
- There is no conclusive evidence to suggest that limpets were being exploited from a particular zone of the shore.
- There is a variation in dogwhelk size between contexts but these variations cannot be explained.
- The morphology of the dogwhelks in the archaeological contexts is very similar to those from the modern shoreline. They are fairly squat in shape, (compared to the archaeological dogwhelks from Oronsay) which is thought to be indicative of a fairly exposed shoreline, but the morphology of the shell can be related to a number of factors.
- There is no meaningful difference in the size of periwinkles, except that it can be noted that modern periwinkles are much smaller than their archaeological counterparts. The reason for this is unknown.

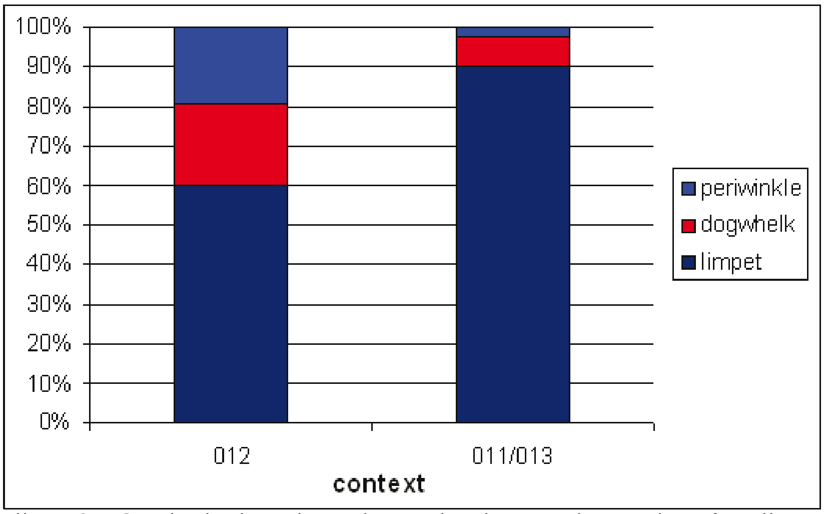
3.12.7.1 A critique of the methodologies employed

Shell midden analysis is expensive and time consuming if dealing with vast quantities of material. For Ferriter's Cove it took over 1,360 hours sorting and identifying shells and fragments (Woodman *et al* 1999:93). For this project, not including the hours spend in the University of Edinburgh sorting the midden material which included identifying and sorting out the shell species, the counting and measuring took in excess of 400 hours. This type of analysis is important but, having finished this project, it is possible to see ways in which economies of both time and money might have been made as well as thinking of ways in which meaningful results can be obtained. Each midden will of course be different and this must always be taken into account, but the following section sets out some of the methodological issues that have been raised.

In terms of sampling, as Claassen (1998:100) has demonstrated, many scholars have discussed how to sample a shell midden but

> "there is no specifiable amount of matrix that can be deemed statistically adequate for world-wide application, nor can there be a fixed size of sample useful world-wide".

In the case of Sand, though only about three quarters of B25B (note: as mentioned in the introduction this encompasses two squares) was sampled for analysis, it is possible that even this quantity was excessive for the purpose of determining an approximation of the relative proportions of species. If instead we take one quarter of the sample and calculate the relative quantities of the predominant species, the resultant bar chart (see Illustration 505, below) is remarkably similar to the original one representing three quarters (see Illustration 493, above). As there are inherent biases in sampling as well as taphonomic issues, perhaps it would be better to examine smaller columns of material (for example 25cm³) right across a midden than expend resources on whole cubic metres. It was certainly beneficial to sample from several areas of the midden which demonstrated that the midden was not homogenous.



Illus 505: Sand, The bar chart shows the three main species of mollusc as a percentage of the total MNI of those species, per context for ¼ of B25B.

In relation to determining relative proportions of species, it is important to consider the ways in which the species are quantified. In this study MNI was used, but in the test pit analysis it was found that weighing was much quicker. The set backs of weighing were highlighted above (Section 3.12.3); however, it is possible that some of these can be dealt with. For instance, the problem of some shells weighing heavier than others can be rectified by taking mean weights of each species and weighting the results accordingly (Section 2.2). This can also be tested using a sample and conducting both MNI counts and weights. If weighing is used it would save a lot more time, however, it would also mean that residues need to be sorted, as much as possible, into species. Woodman *et al* (1999:94) used comparative samples of modern crushed shell to aid in identification of shell fragments. Once the sorters are familiar with residue it need not take long to sort, especially in a midden such as this where limpet predominates and periwinkle and dogwhelks are usually less fragmented and easy to distinguish from limpet.

The measuring results carried out on various species demonstrated in some cases differences between contexts and with modern controls but problems arose with interpreting the results. There are many possible reasons for these changes which are most likely to be connected to changes in the ambient environment, but it is very difficult to identify them. In addition, there also appear to be problems with the morphometric analysis of limpets. It is important to consider whether the modern controls are really comparable and, if they are, what method should be used to identify patterns. The scattergram approach may be more reliable than histograms, though different methods should be tried and tested each time. In their analysis of limpets from La Riera, Spain, Bailey & Craighead (2003) use a more complex method for determining whether limpets were being gathered from low shore, upper shore, sheltered and exposed positions, which includes height, length and width measurements applied to mathematical formulae. It should be noted, however, that this is used for a deep midden sequence spanning the Solutrean to Asturian and this is used in conjunction with other techniques in order to explain size changes noted through the stratigraphy.

Although patterns emerge in many of these studies, it is usually difficult, if not impossible, to interpret the reasons for these. For example Cabral & da Silva (2003) studied limpets from an Iron Age shell midden in Portugal and found that the sizes were very different to modern populations. However, although it was noted that the differences could be due to an increase in wave action and intensity which may be related to an alteration in the morphology of the coast, it was also suggested that it may be related to gathering strategies as well.

There is also little consensus as to why people would be exploiting limpets from either of the different shore zones. Russell *et al* (1995) demonstrate that the limpets were mainly collected from the middle and lower shore and posit that this is perhaps because the lower shore zones were more productive. Mellars (1978:388) discusses work carried out by Fowler (1974) on limpet morphology at Oronsay which indicates that people were gathering limpets from the lower shore. It is suggested that either the limpets are preferable from this location because they are more tender and palatable (see also Russell *et al* 1995; Woodman *et al* 1999) or that this pattern reflects the results of over-exploitation of limpets in the higher and more easily accessible parts of the tidal range and the lower shore is exploited once these are depleted. This however, begs the question, of whether these larger, higher shore limpets are visible in the older layers at the base of the midden. Additionally, Bailey & Craighead (2003:193) hypothesize that in cost-benefit terms they would expect low-shore limpets on sheltered shores to be favoured because this is where the larger limpets grow. The explanation for observed changes at La Riera from the exploitation of lower shore limpets to upper shore limpets in some contexts is that cold and bad weather may have restricted access to the lower shore, as opposed to increased population pressure or over-exploitation.

Perhaps before embarking on measuring limpets we should consider whether the question “Where on the shore are limpets being collected from?” is really an important or interesting question, or even whether any observed changes can be explained. Again this is dependent on the characteristics of the site. In this study the measurement data has provided little insight into the procurement and consumption activities of Mesolithic people or the palaeoenvironment. However, some morphometric analysis on larger middens has proved to be fruitful when built into more complex questions and investigations (for example Bailey & Craighead 2003).

If such studies are to be undertaken, the size of the sample to be measured should also be considered. In this study huge numbers of shells were measured and no sampling strategy was in place. Bailey & Craighead (2003:187–188) provide an interesting example of sampling for measurements. In the original study of the shell material in La Riera cave carried out by Ortea (1986), all of the 15,487 identifiable *P vulgata* were measured. Craighead (1995), however, measured a total of 2,128 spanning 30 layers of midden. What is significant is that, when the results of the two studies are compared, the means of both samples show no significant differences using a Student’s test. There is really only one level where there is a major difference, but here only a very small sample of five limpets was available to be measured by Craighead. It should be feasible in future studies to conduct tests which would determine statistically valid sample sizes so that, for example, perhaps a reduced sample size of 100 shells per context would suffice.

In summary, individual middens vary and it is important to consider what questions to ask before embarking on analysis. On larger or well stratified middens questions relating to changing sizes may be relevant if considering whether intensive human exploitation was taking place or examining changing environmental conditions. On smaller middens such as Sand it is perhaps useful to take other approaches. An estimation of the overall number of shells is useful, partly in deciding what analyses to use but also because it provides an indication of the scale of shell gathering activities. Very little work is usually carried out on accumulation rates which could be related to changes in the deposition of other material remains (fauna, artefacts etc) and theories on the nature and duration of the deposit. Accumulation rates could perhaps be investigated through identifying changes within the middens (for example in shell species, fauna, artefacts, stratigraphy and so on) and a study of shell fragmentation; a rapidly accumulating midden may contain more complete shell than an exposed surface (see also Petersen 2002 in Fischer & Kristiansen 2002). It is also sometimes possible to carry out seasonality assessments and methods on limpets are currently being tested by the author (see also Craighead 1995).

3.12.7.2 Procurement and consumption

The people who were dumping shellfish in this midden appear to be shell gathering on a fairly non-intensive basis. The midden is small compared to some middens in other parts of Europe, but it may also be that many shellfish were processed on the beach and not brought to the midden. The midden is located up from the beach below a rock overhang which would have provided a useful shelter in bad weather, but on better days it is possible that shellfish and other foods were consumed or processed on the beach.

The species of shellfish found on the midden are all fairly easy to procure, mostly living on rocks on the seashore. Although there is sometimes discussion on how limpets are removed from the rocks, because they cling on so tightly, in Charles Darwin’s words when considering the people of Tierra del Feugo:

Illus 506: dogwhelks in a cranny of rocks; these can easily be scooped off

Illus 507: Periwinkles occur in groups on rocks and are easily picked off or scooped up

> "To knock a limpet from the rock does not require even cunning, that lowest power of the mind" (Darwin 1845:206).

Admittedly, Darwin's views were rather biased and he considered these people to be savages, but the general point is true: limpets can easily be removed from rocks with a stone (perhaps a 'limpet hammer') or sometimes even by hand if the limpets have been submerged under water for a long period and they are not dehydrated (Birch, Section 3.4). It is unlikely that it was ever necessary to collect limpets by night (see for example Russell *et al* 1995; Woodman *et al* 1999). Periwinkles and dogwhelks are also easily scooped up. They do not cling so firmly to the rocks and congregate in large numbers (see Illustrations 506, left & 507, right). Although mussels occur less frequently in the midden, there may be some taphonomic bias at work and if this species was readily available on the shore, it too could easily have been collected in large numbers.

Once gathered, the shellfish may have been used for a variety of purposes, for example food, bait, ornaments, tools and it has even been suggested that dogwhelks may have been used as a source of dyestuff (Cerón-Carrasco 2005; Gibbons & Gibbons 2004; Hardy, Section 3.4). The archaeological shell, however, provides little clue towards the purpose or purposes for which different shellfish were used and the discussion is thus speculative.

The limpets which were taken back to the midden and processed could have been consumed in a number of ways. They are easy to remove from their shells, either by using a finger to scoop out the flesh (Birch, Section 3.4), or perhaps using another limpet shell (Fenton 1984:128). They may have been eaten in different ways: raw; lightly boiled or cooked with other foods, for example the survival expert Ray Mears cooks them up with seaweed. Very few, if any, signs of heating were noted on the limpet shells but, even when it does occur, this may not be related to cooking and could for instance be a result of accidental heating.

The other predominant species may also have been eaten: periwinkles are usually regarded as edible. They can be boiled which makes them easier to extract from the shell and then removed with a pin or similar implement as opposed to smashing the mollusc when fragments of shell get into the meat. Many of the periwinkle shells found on the site were whole and not fragmented. Mussels are also considered edible and again could have been boiled or roasted. As with the other species of shell, the mussel may have been cooked along with other ingredients. With regard to dogwhelks it is harder to find accounts of people actually eating this species. They are often thought to be very unpalatable and because they are carnivores their flesh is supposed to have a rather distinctive and unpleasant taste. However, chef Hugh Fearnley-Whittingstall (2001:304) does mention dogwhelks in several of his recipe books and suggests they can be gathered from the shore, boiled and eaten (with mayonnaise) and they are eaten in the Azores (Janice Light *pers comm*). It has also been suggested that periwinkles and dogwhelks may have been collected to add variety to the diet (Mellars 1978; Russell *et al* 1995), perhaps in much the same way as gastropods were collected to add variety to the Anbarra diet (Meehan 1982).

There is also the possibility that shellfish may have been gathered and used as fish bait. Fenton (1978 & 1984) recounts ways in which shellfish have been used as bait in recent times in Scotland and investigations have been carried out on the use of limpet bait in Viking Orkney (Milner 2004a). Mussels make excellent bait and were used so much that, by the nineteenth century, the supply of mussels could not keep up with demand. Limpets can also be used in a variety of ways but tended to be used for inshore fishing. One method in the Northern Isles was craig-fishing or fishing from the rocks. This involved mashing limpets into bait and scattering them on the water or chewing partly boiled limpets and spitting them out. This particularly attracted sillocks (year old coalfish or saithe) which could then be fished with a rod and fixed line or a net. Nets would be lowered into the water and the limpet mash thrown onto the surface of the sea, thus attracting a shoal of fish which can be caught in great numbers when the net is raised (Fenton 1978:538). The fish found in the midden at Sand are dominated by wrasse, young saithe and young pollack, all of which are found close to the shore and could have been caught by these methods (Parks, Section 3.11).

As shells are found on the Mesolithic middens, it could be argued that they are more likely to have been consumed directly than used as bait: why carry shellfish to camp and then back to the beach for fishing when they could be processed on the beach? However, historical accounts show that in some areas limpets were transported home to be shelled (Fenton 1984:128) and they were on occasion then left to rot a little as this made for better crab bait. As suggested in the analysis of the crab remains (Milner, Section 3.13), one method to use limpet bait is to punch holes into the limpet shells in order to string them onto lines. If they were used as bait in some form of trap or basket, they would then be returned to the midden along with the catch. The point here is not to prove that limpets were being used for fish bait but rather to raise the possibilities. In the long run, though it is likely that some limpets were being used for fish bait, it is also feasible that they were being used in direct consumption and perhaps in other ways.

The shells were also useful for other things. They may have been used as ornaments, and they provide a useful raw material suitable for a range of tasks. There is good ethnographic evidence for the use of shell in a number of ways (for example Stewart 1996). In addition to sharp edges (for example razor shell) shell may be cut and shaped and is relatively durable. Worked shell from Sand is discussed elsewhere (Hardy, Section 3.5).

In addition, there has been discussion in the literature as to whether dogwhelks might have been used to make purple dye in the Mesolithic, particularly at Ferriter's cove, Ireland (Gibbons & Gibbons 2004), and Geodha Smoo, Scotland (Cerón-Carrasco 2005). The dogwhelk has a vein of clear liquid near the head and this, when exposed to sunlight, turns green and then purple. The process of extracting the dye is not particularly straightforward however; careful extraction is needed and simple smashing out of the shell does not serve. An account by William Cole (1685) describes how the animal can be cracked open, the shell picked off, the vein dug out and the liquid applied to fine linen or silk. Large quantities of dogwhelks would be needed to create a usable amount of dye, and mordants and additives are also necessary (Janice Light *pers comm*), though perhaps not for some purposes such as temporary body paint. The small quantity and condition (that is whole) of the dogwhelks from Sand make it unlikely that people were using them for dye, furthermore, had this been the case, perhaps we would have expected the shells to be lumped together rather than scattered through the middens.

3.12.8 Conclusion

If we try and picture how people were using shellfish at the site of Sand, it is likely that many of the shellfish were consumed directly as an ingredient of a varied diet. In addition, they are likely to have served a number of other purposes such as bait and tools. Historically, the consumption of shellfish, especially species such as the ones found here, is often connected with poverty and a lack of cultural development. Therefore, discussions on the consumption of shellfish in the Mesolithic have all too often led to bleak images of hunter-gatherers eking out a sparse living on the coast. This perspective can be traced back to early historical accounts such as Darwin's observations of the Fuegians, during his voyage on the Beagle. He described these people as

> "living chiefly upon shellfish" (Darwin 1845:202)

and noted:

> "whenever it is low water, winter or summer, night or day, they must rise to pick shell-fish from the rocks; and the women… sit patiently in their canoes, and with a baited hair-line without any hook, jerk out little fish. If a seal is killed, or the floating carcass of a putrid whale discovered, it is a feast; and such miserable food is assisted by a few tasteless berries and fungi". (Darwin 1845:204).

In this 19th century account the Fuegians were also described (amongst other things) as poor wretches, wild men, cannibals and barbarians which was the type of image some archaeologists in the early 20th century projected onto the shell gathering people of the Mesolithic period (for example Childe 1925 & 1956). Clark (1952:62) also comments that diets in which shellfish are a mainstay are usually associated with a low level of culture, although he may be referring to the views of others such as Childe, rather than his own perception of Mesolithic people which tended to be more positive. In the case of the Fuegians, many of these early preconceptions have since been deconstructed (McEwan *et al* 1997).

Many other ethnographic sources also describe shellfish as a 'poverty' food. As Fenton (1978:542) notes, the Shetland saying "to gang i' da wylk ebb" means "to be reduced to poverty". However, these attitudes are modern and biased and should not be applied back to the Mesolithic period: shellfish have perhaps been considered a food of the poor in recent times because they are free and can be gathered by people who have no money to buy food, but all food was 'free' in the Mesolithic, and resources and food would have been viewed very differently. Indeed, Wickham-Jones (2003) has shown that limpets are considered a delicacy in some areas of the world and can be used in a variety of ways including as charms and for medicinal purposes.

The preconceptions that shellfish represent a time of poverty and hardship contrast strongly with the luxury role of shellfish in today's culture. Rather than using modern perceptions to view the consumption practices of the past, it is perhaps more useful to consider the ways in which people were procuring and consuming foods in the past and to reflect on the variety and richness of resources that would have been available to them. In the case of Sand, we can see that shellfish were an integral part of life: not only as a raw material but also as part of a rich and varied diet which also included other marine species such as crab and fish, terrestrial animals and, no doubt, plants.

Published by The Society of Antiquaries of Scotland, in association with
the Council for British Archaeology and Historic Scotland.
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Use http://www.sair.org.uk/sair31 to cite this page.
ISSN 1473-3803; ISBN 978 090390361 5

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