An analysis of the marine molluscs from the Mesolithic site of Sand, Scotland

Nicky Milner, School of Historical Studies, University of Newcastle upon Tyne, Newcastle upon Tyne, NE1 7RU, n.j.milner@ncl.ac.uk

1. Introduction

Shell middens on the western coast of Scotland were first investigated in the 19th century and since then many others 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 (e.g. Andersen 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 producing cave sites with midden deposits, such as MacArthur Cave, the Druimvargie rockshelter, and Carding Mill Bay (Connack 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). In the last couple of years, many more sites including shell middens have been discovered around the Inner Sound (Hardy and 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 Mesolithic people 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 Oronsay middens in the 1970s excavations providing information on the procurement methods and palaeoenvironment (Andrews et al 1985; Mellars 1978). Similar types of 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. The aim of the analysis is to look for changes in the morphology of the shells and the composition of the midden which might indicate changes in shellfish gathering and consumption through time. It is also 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.

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. The counts provide information on the relative abundance of different species. Measurements were made on the three dominant species; limpets, periwinkles and dogwhelks. These were taken because they can be used 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 check changing size through time, which might indicate changing environmental conditions or pressure, possibly human, on the natural resources.

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. 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 (see for example Mellars 1978). 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.

This paper has been divided into sections which firstly deal with the methodologies employed; sampling methods and quantification of species. The analysis of the three main species (limpet, dogwhelk and periwinkle) is then presented. Finally the nature of procurement methods and consumption practices will be discussed.

2. Sampling

When carrying out shellfish analysis a shell midden, unless it is very small, has to be sampled simply because of the vast quantities of shells which are usually found: in the Danish midden of Norsminde it was estimated that there were 83 000 shells within 1 cubic metre (Bailey and Milner in press). For the site of Sand, discussions with Karen Hardy led to the selection of the square B24b in Trench B for analysis. This was the central area in which the midden thickened and there were several contexts through the stratigraphy. In addition, analysis was undertaken in trench A in order to provide a comparison: squares A1b to A6b were sampled. These squares are close to the edge of the shell midden and stretched for 6 metres downhill. There was less shell material in these squares, especially further down the slope. The squares at the top (A1b and A2b) consisted of what appeared to be tipped material that had slumped from the midden upslope and so could possibly be younger deposits. In all areas, although contexts were identified, every square was excavated in spits and these were divided into quadrants (NE, SE, SW, NW).

Within square B24b there are three contexts. At the top of the midden there is a layer of crushed shell about 0.05m in depth running along the midden deposits (012). The bulk of the midden was made up of a dense mass of unconsolidated shell (013) which during excavation was noted to be made up mainly of intact limpet shells. Towards the south eastern part of area B1 was a darker grey and ashy layer of shells (011) identified as the only evidence of stratigraphical variation within this part of the shell midden.

The six grid squares A1b to A6b were fully excavated to bedrock. A shell-mixed topsoil (001/2) 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 shellmidden material (028) which appeared to represent tip from the sloping front edge of the midden. This tipped shell material overlay organic rich deposits (022) which had comparatively little shell content and some stony slumping (027) which had even less shell material. Below this lay a sterile palaeosol layer (025) (although a few shells are assigned to this context). Overlying the midden deposits were sandy soils containing a high percentage of small and fragmented heat affected stones (029 and 017). These layers have been interpreted as slopewash and extended for about 2.5m downslope where the stones had built up against some large boulders.

All 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 B24b and A trench 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 B24b would be analysed; however with the resources available this was not possible and so it was sampled. About three quarters of the square was analysed, table 1. All of the six squares in trench A were analysed, although there was far less material from this area.

spit	context	NE	NW	SE	SW
2	012	X- spit not divided into quadrants			
3	013	X		X	X
4	013	X	X		X
5	013		X	X	X
6	011			X	X
7	011	X	X	X	X
8	011	X	X	X	
9	011	X		X	

Table 1: Figure showing which quadrants were analysed in square B24b.

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. Weighing as a method though, appears to be of little use when applied to the less abundant species. 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 in the gastropods which could not be removed. The method which has been used for Sand is the quantification of MNI.

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, e.g. 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 Appendix 1. 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 a couple of hundred apices had been missed, compared with several thousand in total, the relative frequencies of species should not be greatly affected. In the case of the A trench all the residues were scanned.

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. This can include perforation, fragmentation, abrasion, encrustation, dissolution and heating (see Claassen 1998 for a thorough review). Perhaps one of the most critical points to make when quantifying shell is that differential preservation appears to occur in these middens, i.e. some species appear to decay more rapidly than others. In the case of Sand, gastropods like the periwinkle and dogwhelk are comparatively robust, and they often appear as whole specimens, but the structure of the shell continues to appear tough. Other species, the 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. The likelihood is therefore, that this species in particular is substantially under-represented on many sites and it is believed that this may be the case for Sand.

3.1 Description of species

The following descriptions of species identified are taken from Barrett and 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 very pronounced ribs and a jagged aperture, whereas the second group has a very smooth exterior and a smoother aperture; but it was not clear whether this variation indicated that they represented different species, figure 1. 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. 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 very subject to morphological convergence and the observable differences of smooth and ribbed are probably exhibiting shell features which characterise their living environments. It is therefore possible that the shells were coming from different levels on the shore, or from different degrees of exposure/shelter, or from different sites. In this case 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 areas.

Figure 1: the difference between the smooth and the ribbed limpets.

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. They can be used either as bait or directly as food. This will be explored in detail in the discussion section at the end.

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 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 etc) and is more likely to be collected because of its aesthetic qualities or because it is attached to weed, rather than for consumption purposes. It lives on the middle and top shore, especially on the *Fucus* weed. Periwinkles are easy to pick off the rocks and because they congregate in large numbers a great number can be scooped off at once, figure xxx.

Figure xxx: Periwinkles occur in groups on rocks and are easily scooped up

The other fairly dominant species here 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 (they secrete a substance which can be used as purple colouring) however, very large numbers would be needed to make even a small amount.

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 and 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.

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 abundance. 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 immense 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. Some may have been consumed, but the shells may also have been collected because the large flat valves make good "plates" and the lower convex valves make good containers. A scallop from the site does appear to have been worked and there are several more fragments through the midden. Scallops that have been collected empty and that have been worked have been found at other sites, e.g. Ulva and Oronsay (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 this site 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 utilised in some way.

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 (will not) have been gathered intentionally but either were transported to the site on seaweed, on which 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 slightly surprising because in most other similar assemblages oysters are found, even if in extremely small numbers (Russell et al 1995; Smith 2001; Mellars 1987). However, the majority of species here are rocky shore dwelling species and perhaps oysters, which tend to be submerged and attached to a firm substrate, were either not available in this environment or not sought after.

3.2 Relative proportions of species

3.2.1 Square B24b

Eight species have been identified in this square, table 2. The quantities of the 3 dominant species (limpet, dogwhelk and edible periwinkle) can be compared in bar chart form, see figure xxx. The dominant species in this square is the limpet in each of the 3 contexts, with dogwhelk second and periwinkle third. In 012, the top layer, the percentage of limpet to other species is lower (60%), with almost equal proportions of dogwhelk and periwinkle but in both 013 (the main midden context) and 011 (the ashy layer) the limpet constitutes over 85% of the sample. Mussel constitutes about 1% of the assemblage in each context. However, as mentioned above, taphonomy is likely to have been an influence here and we can assume that there was probably a greater numbers of mussels in all contexts.

context	limpet	dogwhelk	periwinkle	mussel	flat periwinkle	clam/ scallop	topshell	cockles	total MNI
012	1028	358	331	17	3	1		2	1740
013	18424	1746	929	199	11	1	5		21315
011	14457	1775	263	168	10		1		16674

Table 2: Table to show MNI for each species per context in square B24b.

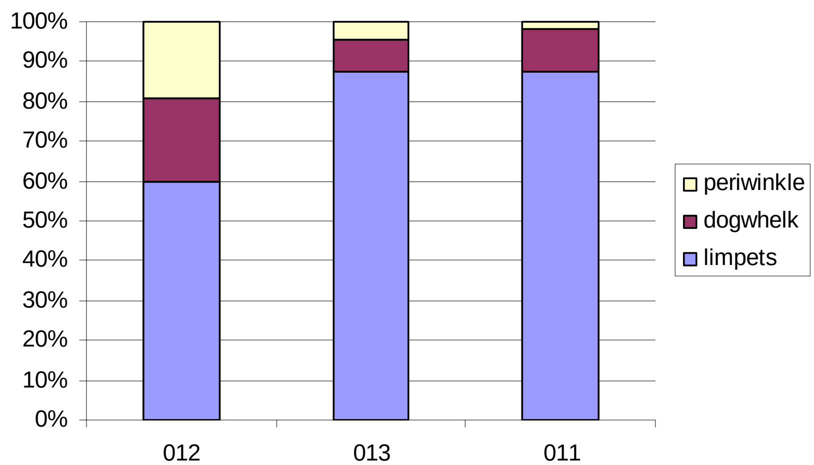

Figure xxx: The bar chart shows the three main species of mollusc as a percentage of the total MNI of those species, per context.

3.2.2 Trench A

Eight species have been identified in the A trench. The MNIs of seven of these species can be seen in table xxx and the presence of razor shell is denoted by an x. These results are presented in graph form in figure xxx.

context	limpet	periwinkle	dogwhelk	cockle	flat periwinkle	mussel	clam/ scallop	razor	total MNI
001/2	3746	916	633	12	11				5318
028	2471	903	608	9	8	3		x	4002
022	145	348	167	1		1			662

027	17	64	21						102
029	680	214	192		1	1	1	x	1089
017	107	58	37	1	1			x	204
025	2		1						3

Table xxx: MNI and presence of species in the A trench

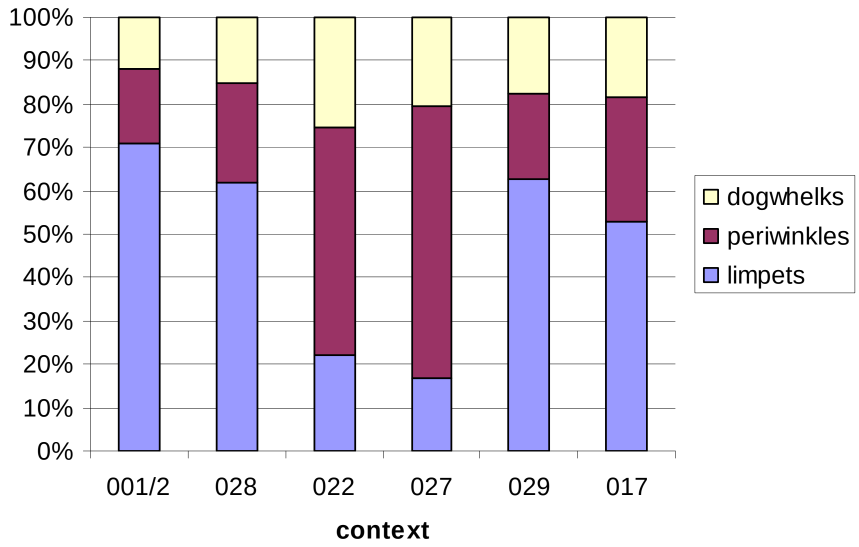

Figure xxx: Trench A; the bar chart shows the relative proportions of the three main species as a percentage of the total number of shells per context (025 has been excluded because the total MNI is so small)

Shells from 001/2 (shell mixed topsoil) were analysed from A1b and A2b. It can be seen from figure xxx 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 tip from the sloping front edge of the midden (028) the composition of shell species is very similar to the shell-mixed topsoil (see figure xxx) i.e. mainly limpets, followed by periwinkles and dogwhelks and small numbers of mussels, flat periwinkles and cockles. There was also a significant quantity of razor shells from this context.

Context 028 overlay organic rich deposits (022) which had comparatively little shell content. Here, the dominant species is periwinkle. Context 028 also overlay some stony slumping (027) which had even less shell material but, like 022, has a predominance of periwinkles. The sandy soils above the midden (017, 029) contain a relatively small number of shells with limpet as the dominant species followed by periwinkles and dogwhelks but very few other species, although there does appear to be razor shell 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 downslope there was no midden (squares A5b and A6b) although 3 shells were found in 025 (A6b), probably having fallen downslope (consequently this has not been represented graphically).

1.3 Comparison of the A and B trenches
It can be estimated that there are about 50,000 shells within the square B24b. In A1b there are approximately 8500, 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 and constitute the whole midden but if the squares around B24b are similar in size and then tail off as they do in the A trench then a very rough approximation could be anything between 250 000 and 500 000 shells.

There appears to be some degree of homogeneity throughout the midden: limpets tend to predominate, with the exception of contexts 022 and 027 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.

There appear to be more mussels in B24b than 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 these 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 B24b. Conversely, razor shell is present in trench A but does not appear to be present in B24b.

In terms of relative proportions of species there is a greater amount of limpet in B24b. In contexts 013 and 011 limpets constitute almost 90% of the material. In trench A, however, there is no more than 70% limpet in any context and in fact if the topsoil (001/2) is not included then limpet can only account for 50-60% of the shell material in contexts 028, 029 and 017. The contexts at the base of the midden, 022 and 027, are interesting in that they contain a majority of periwinkles.

In sum, the differences observed between the two areas are very probably significant. Trench A is thought to represent tipping from further upslope, i.e. in the vicinity of B24b. It is likely that the deposits in trench A are slightly later stratigraphically and perhaps even came from above the contexts now in B24b. The observed differences may subtly represent different gathering strategies through time. These differences can be investigated further by taking measurements of the shells.

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 (e.g. Mannino and Thomas 2001; 2002; Milner 2004). To (truly) 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. 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 sizes have been compared 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 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 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.

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 have been excluded because the sample size is too small. Results from 001/2 and 028 will be used. A good sample size was also obtained from all three contexts in B24b: 012, 013 and 011. The measurements of all limpets can be found in appendix 2.

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

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 028 is slightly greater than the other means, figure xxx. 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, i.e. 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 5). There is, for example, a difference between 013 and 011 even though the means are very similar. The modern controls are different to all the archaeological contexts (with the exception of the lower shore limpets and 028), and each other.

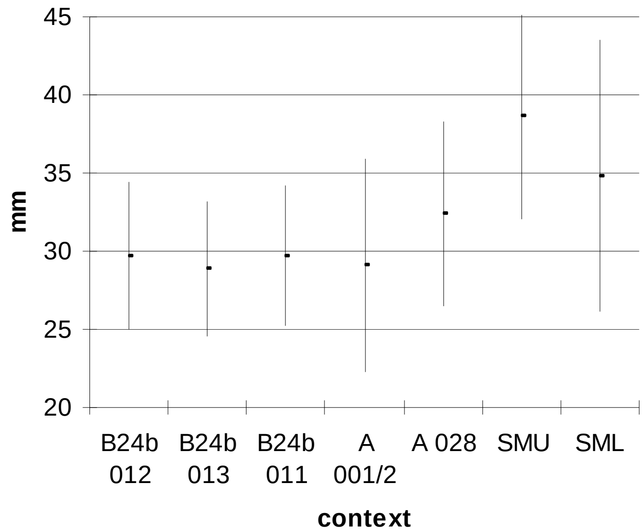

Figure xxx: average length and standard deviations for limpets from Sand. SMU= Sand modern upper shore (N=50), SML= Sand modern lower shore (N=51), 012 (N=391), 013 (N=7350), 011 (N=4399), 001/2 (N=82), 028 (N=72)

The problem arises when trying to interpret these differences. There can be many reasons for change 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 (e.g. Mannino and 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 being gathered by humans, but there may also be some environmental explanation; the ambient environment no doubt having changed in many subtle ways since the Mesolithic.

Relatively speaking, this midden 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 western 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 may suggest that limpet gathering was a fairly sporadic activity carried out on a small scale. Although there could be 250,000 shells within the midden, it must be remembered that they were probably accumulated over a long period of time and it would only take 1000 shells (or 10 days x 100 shells) to be collected every year for 250 years to create this midden. It is unlikely that the gathering of 1000 limpets a year would make a significant impact; the collection of 100 modern limpets on the beach appeared to be a very small percentage of the overall population. 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.

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4.2 Morphology

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. Usually histograms are used to present this data (Mellars 1978, fig8; Russell et al 1995; Smith 2001, illus 61) but scattergrams can be equally informative. It has been shown above that the modern limpets exhibit differences to the archaeological ones so they should not be taken as directly comparable; however, they do serve to demonstrate that when the length of the limpet is plotted against the height a clear difference in shape is exhibited, figure xxx.

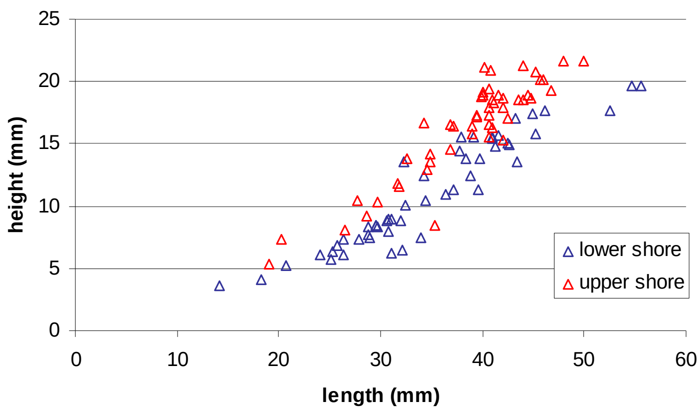

Figure xxx: scattergram plotting the height against the length of modern limpets, collected from the lower shore and upper shore at Sand, October 2003.

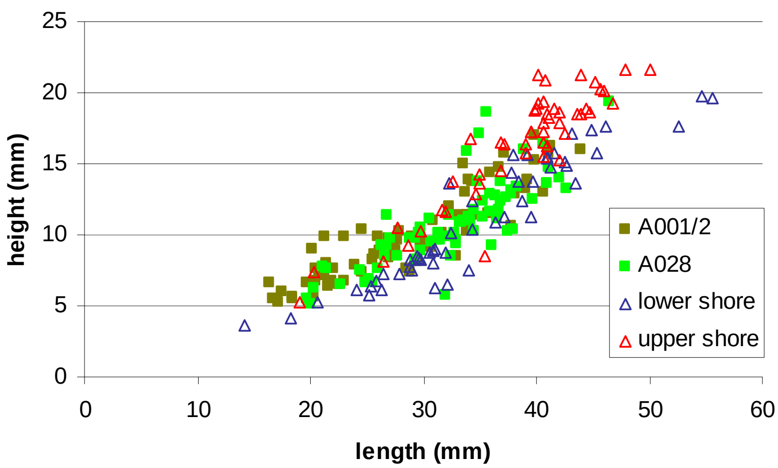

Figure xxx: scattergram plotting the height against the length of limpets from trench A, contexts 001/2 and 028 and this is then overlain by the data from the modern limpets

The limpets from B24b and trench A (the vast majority of measurements are taken from A1b) were measured and the ratio of height to length calculated. In trench A there are only enough limpets from two contexts (topsoil 001/2 and midden 028) to make any statistically valid comparisons. From figure xxx, it is clear from the overlap in the distribution of points that the morphology of the limpets from both contexts is the same. When compared to the modern limpets, as already demonstrated above, the modern limpets are larger. The modern upper and lower shore limpets fall within the archaeological scatter suggesting a mix of limpets were gathered from both shore zones. The smaller limpets tend to fall within the modern upper shore limpets, but because there are far fewer limpets of this size from the modern collection it is not possible to say whether this is significant.

For each of the contexts in B24b a random sample of 150 limpet measurements has been plotted. The scatter of modern limpets again falls over the archaeological distribution suggesting that both shore zones were exploited. Again it is difficult to compare the modern limpets with the archaeological ones because the modern ones appear to be much larger.

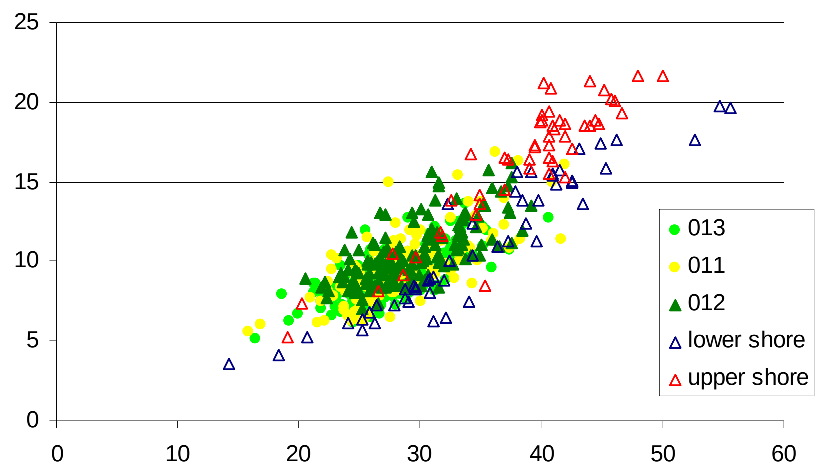

Figure xxx: scattergram plotting the height against the length of limpets from B24b and measurements from the modern limpets

The results of this analysis show that both tall and squat limpets were being collected, and the likelihood is that one zone of the shore is not being specifically targeted. 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, e.g. at Caisteal nan Gillean, Oronsay (Mellars 1978, 387), Ellary Boulder Cave (Smith 2001, 114) and Ferriter’s Cove (Woodman et al 1999, 99). This pattern has been explained through the idea that limpets are supposedly more succulent nearer the low tide mark. It is possible, however, that the use of histograms in presenting this type of data masks the overlap between upper and lower shore zones. 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.

5. Dogwhelk size and morphology

Dogwhelks can be measured like the limpet in order to determine whether there is any change in shape or size through the midden. 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 palaeoenvironment (e.g. 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 in the present. 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, although it is also suggested that the changing morphology may be attributed to changing coastal configuration through changing sea-level through the Holocene.

5.1 Comparison of average length

It can be seen in figure xxx, that there appears to be a small difference between dogwhelks in B24b and those in the A trench: if the A trench 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 .05 level and these demonstrated further differences between the contexts within B24b but no real differences between the A trench contexts. The modern dogwhelks are shown to be different to the B24b dogwhelks. As with the limpets, it is very difficult to provide a reason for these differences.

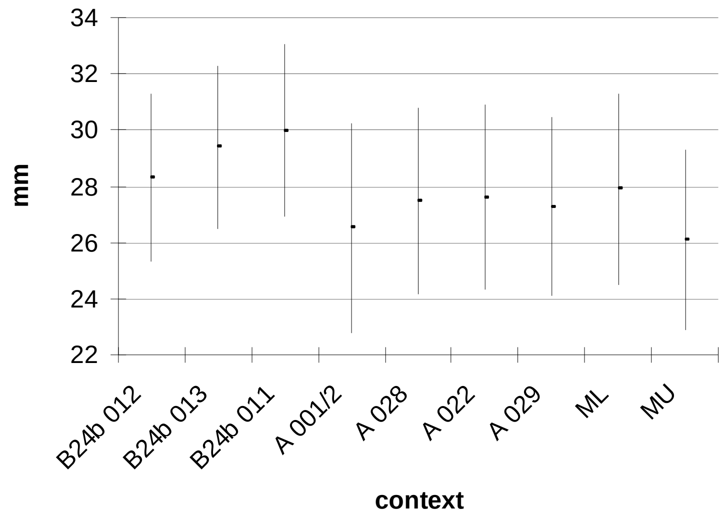

Figure xxx: average length and standard deviations for dogwhelk length from Sand. 012 (N=249), 013 (N=1028), 011 (N=305), 001/2 (N=350), 028 (N=326), 022 (N=65), 029 (N=58), ML= modern lower shore (N=50), MU= modern upper shore (N=50)

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. Figure xxx shows the typical distribution of ratios. The dogwhelks from the modern shore are also the same, figure xxx.

Compared with the dogwhelks from Oronsay these are very squat. 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 (Smith 2110; 116). The dogwhelks from Sand look to be fairly similar to the archaeological samples from Ulva although these may be even slightly squatter (Russell et al 1995: figure 13).

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 are more elongate suggesting a sheltered shore. However, there are some caveats to the interpretation of the ratio being 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 an unknown) and 2. the genetics which may influence shape are also poorly understood and may apply differently to island populations (Andrews et al 1985).

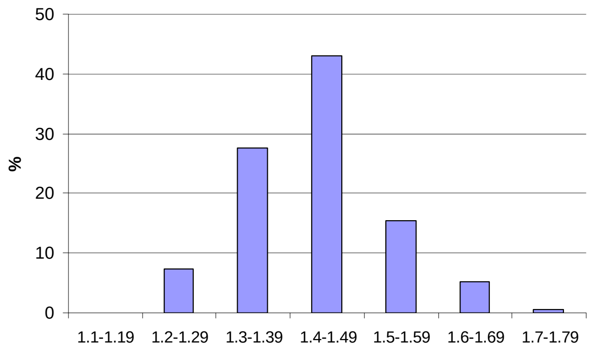

Figure xxx: frequency histogram of dogwhelk length/aperture ratios from context 028 (N=326).

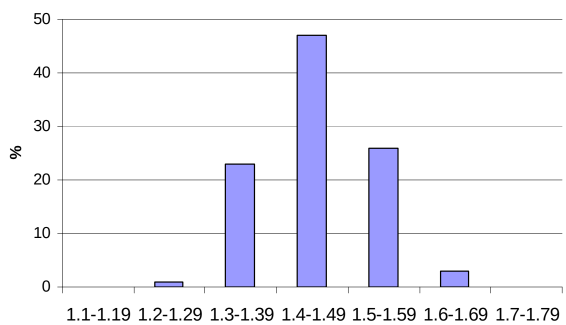

Figure xxx: frequency histogram of dogwhelk length/aperture ratios from the collection of modern dogwhelks (N=100).

6. Periwinkles

The edible periwinkle is fairly robust and survived well in the midden. 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, figure xxx (e.g. Russell et al 1995; Milner 2004). 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 which appear to be larger than their archaeological counterparts, the periwinkles are much smaller on the beach today. The reason for this is unknown.

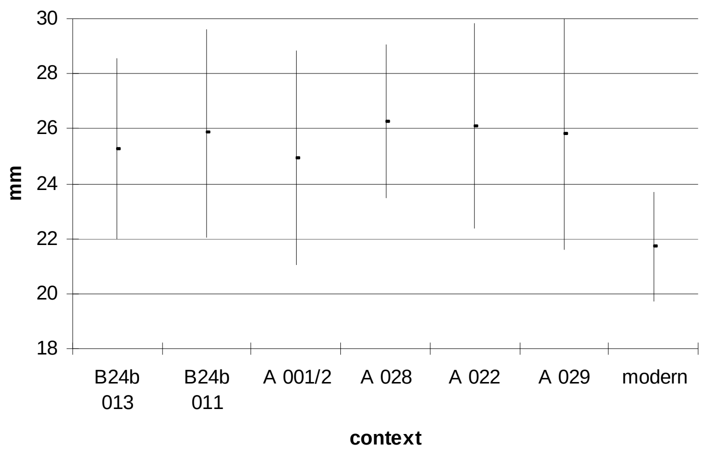

Figure xxx: average length and standard deviations for periwinkles from Sand. 013 (N=777), 011 (N=171), 001/2 (N=302), 028 (N=254), 022 (N=105), 029 (N=61), modern (N=50)

7. Discussion and conclusion

In sum the following results can be presented:

- Like all the other middens in this 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 (022) and some stony slumping (027). These may represent a slightly different episode of gathering or consumption, which could be a result of many different things, such as a change in seasonal gathering.
- There are a number of other species present but these occur in much smaller numbers. Some may have been consumed (e.g. possibly the razor shells), some may have been gathered for their aesthetic qualities or perhaps accidentally (e.g. the flat periwinkles) and some may have been used for other purposes, e.g. scallops as implements.
- There are some differences between the two areas of the midden, B24b and trench A: there is more mussel in B24b; limpet constitutes a greater percentage of the assemblage in B24b; 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 other similar middens. The assemblage is a rocky shore assemblage however, and very few other bivalves are present either.
- It is estimated that there are about 50,000 shells within square B24b and about 9000 in the A trench. A very approximate estimation would suggest anything between 250,000 and 500,000 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.

- 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 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.

The people who were dumping shellfish in this midden, therefore, appear to be shell gathering on a fairly non-intensive basis. At the moment there is no data to demonstrate any seasonal pattern to the shell gathering, although this would be an interesting project for the future. There is some variety in the assemblage and it may be that some species, like the mussel was gathered in greater quantities than has been calculated here, but due to its susceptibility to degradation it is hard to be sure on what scale. The midden is fairly small compared to some middens in other parts of Europe, but it may also be the case that many more shellfish were processed on the beach and simply 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 very likely that shellfish and other foods were consumed or processed on the beach.

One question remains, and that is whether the shellfish were used as food or for fish bait. This is an interesting question but remains largely speculative. Many archaeologists relate Mesolithic shellfish gathering with food and consumption and small sites are often referred to as "dinner time camps" after Meehan's (1982) ethnographic work with the Anbarra. However, the consumption of shellfish in the Mesolithic has been equated with bleak images of hunter gatherer people eking out a living on the coast. This perspective can be traced back to Darwin's voyage on the Beagle and his observations on the Fuegians, who he described as "living chiefly upon shellfish" (Darwin 1997: 202) and:

"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 1997, 204).

This is of course a 19th century perspective and the Fuegians were also described as poor wretches, wild men, cannibals and barbarians (amongst other things) but these perceptions have been deconstructed and it has been shown that shellfish were not the main subsistence food of these people (McEwan et al 1997). This type of picture has, however, sometimes persisted in the Mesolithic literature: Clark (1952: 62) for instance suggests that diets in which shellfish are a mainstay are usually associated with a low level of culture. Ethnographic sources do usually describe shellfish as a “poverty” food. In the nineteenth century whelks, for instance, were regarded as low status or an emergency food and Fenton (1984: 123) has translated a Gaelic saying as “whelks will keep a man alive until he grows as black as the whelk’s own excretion”. However, this attitude should not be applied back to the Mesolithic period: shellfish have perhaps been considered a food of the poor in recent times because shellfish are free and can be gathered by people who have no money to buy food, but all food was “free” in the Mesolithic and hence may have been perceived differently.

Limpets are not considered by most to be a luxury, as oysters often are, but they are sometimes eaten in Scotland today because they are easily gathered on the beach. Wickham-Jones (2003) has also recently shown that limpets can be also used in variety of ways including being eaten as delicacy, employed as charms and used for medicinal purposes.

There is also some debate on whether dogwhelks are good to eat. Because they are carnivores their flesh is supposed to have a rather distinctive and not necessarily pleasant taste. Some have suggested that they may have been used to make purple dye but it seems unlikely because of the small numbers found. They should not be ruled out as food and in fact a recipe can be found in one of the books of TV chef Hugh Fearnley-Whittingstall (1997). 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).

However, there is the possibility that shellfish may have been gathered and used as fish bait. Fenton (1978; 1984) recounts some ways in which shellfish have been used as bait in recent times in Scotland. 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 line fishing. One particular way 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 up in the mouth and spitting them into the sea. This attracted coalfish which could be fished with a rod and fixed line or a net. Limpets could also be used to catch saithe, cod and haddock.

The fact that shells are found on the Mesolithic middens has sometimes been used to argue that they are being consumed directly and are not being used as bait: why carry shellfish back to the camp and then back to the beach for fishing when they could be processed on the beach? It is very interesting to note that in some areas limpets were collected and taken home to be shelled (Fenton 1984). This was usually done by the children using one of the shells as a scoop (rather than a tool like the “limpet scoops” found on the Mesolithic midden sites). The shellfish were then left in clean water and kept for about a week which helped them to soften which would allow the fish to take the bait more easily. It is easy to imagine that the limpets were perhaps left lying on the midden for a period in order for the same process to occur.

There are also a significant number of limpets with holes in them on the Mesolithic midden, see figure xxx above (these are discussed more by Karen?). Limpets with holes in them like these can be found naturally washed up on the beach and perhaps they were gathered dead and used for some other purpose, like jewellery for instance (Wickham-Jones 2003). But, there are so many of these limpets on the site that it is also feasible that the holes were made purposively at the midden. One possibility is that these limpets could also have been used as bait. The holes could have been made in the shell, then the limpets threaded onto a cord and strapped to baskets for catching crabs. The limpets could even have been left for a short while to rot and then the baskets taken to the beach and submerged. Later the baskets with the catch and the limpets would be returned to the midden and processed (Nick Winder pers comm). This is purely speculative and there is no evidence for this except that crabs are present on the site and there may have been some method and bait used to catch them.

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The debate on whether shellfish were used for bait or for food is not resolved but it is useful to consider the possibilities and use ethnography to advance ideas. The likelihood is that they were used for both but we may never know in detail exactly how or in what proportions.

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Bibliography

Anderson, J. 1898. Notes on the contents of a small cave or rock-shelter at Drumvargie, Oban; and of three shell mounds in Oronsay, *Proceedings of the Society of Antiquaries Scotland*, 29 (1894-5), 211-230

Andrews, M.V., Gilbertson, D.D., Kent, M. and Mellars, P.A. 1985. Biometric studies of morphological variation in the intertidal gastropod Nucella lapillus (L): environmental and palaeoeconomic significance, *Journal of Biogeography* 12, 71-87

Bailey, G.N. and Milner, N. in press. The marine molluscs from the Norsminde shell midden, in S.H. Andersen (ed.) *Stone Age Settlement in the Coastal Fjord of Norsminde, Jutland, Denmark*

Barrett, J and Yonge, C.M. 1958. *Collins Pocket Guide to the Sea Shore*. London: Collins

Brehaut, R.N. (1982) *Ecology of Rocky Shores*. London: Arnold

Claassen, C. 1998. *Shells*. Cambridge: Cambridge University Press

Clark, J.G.D. 1952. *Prehistoric Europe. The Economic Basis*. London: Methuen and Co. Ltd

Connock, K.D., Finlayson, B. and Mills, C.M. 1992. Excavation of a shell midden site at Carding Mill Bay near Oban, Scotland, *Glasgow Archaeological Journal 17*, 25-38

Darwin, C. 1997. *The voyage of the Beagle. Journal of researches into the Natural History and Geology visited during the voyage of HMS Beagle round the World, under the command of Captain Fitz Roy, RN*, Hertfordshire: Wordsworth Classics of World Literature

Fearnley-Whittingstall, H. (1997) *A Cook on the Wild Side - the indispensable guide to collection and cooking wild food*, Boxtree

Fenton, A. 1978. The Northern Isles: Orkney and Shetland, Edinburgh: John Donald

Fenton, A. 1984. Notes on shellfish as food and bait in Scotland, in B. Gunda (ed.) *The fishing culture of the world. Studies in ethnology, cultural ecology and folklore*, Budapest: Akadémiai Kiadó

Gibson, R., Hextall, B., and Rogers, A. 2001. *Photographic guide to the sea and shore life of Britain and North-west Europe*, Oxford: Oxford University Press

Hardy, K. and Wickham-Jones, C. 2002. Scotland's First Settlers: the Mesolithic seascape of the Inner Sound, Skye and its contribution to the early prehistory of Scotland, *Antiquity* 76, 825-33

Mannino, M.A. and Thomas, K.D. 2001. 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, 1101-1114

Mannino, M.A. and Thomas, K.D. 2002. 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*, vol 33(3), 452-474

McEwan, C., Borrero, L., and Prieto, A. 1997. Patagonia. Natural history, prehistory and ethnography at the uttermost end of the earth, London: British Museum Press

Meehan, B. 1982. *From shell-bed to shell-midden*. Canberra. Institute of Aboriginal Studies

Mellars, P.A. 1978 Excavation and economic analysis of Mesolithic shell middens on the Island of Oronsay (Inner Hebrides), in P.A. Mellars (ed.) *The Early Postglacial settlement of Northern Europe*, London: Duckworth, 371-396

Mellars P.A. 1987. *Excavations on Oronsay. Prehistoric Human Ecology on a small island*, Edinburgh: Edinburgh University Press

Milner, N. 2004. Quoygrew, Westray, Orkney: an analysis of the marine molluscs, unpublished report, University of Newcastle upon Tyne

Pollard, A. 1990. Down through the ages: a review of the Oban cave deposits, *Scottish Archaeological Review 7,* 58-74

Pollard, T., Atkinson, J. and Banks, I. 1996. It is the technical side of the work which is my stumbling block. A shell midden site on Risga reconsidered, in T. Pollard and A. Morrison (eds.) *The Early Prehistory of Scotland*, Edinburgh: Edinburgh University Press

Russell, N.J., Bonsall, C, and Sutherland, D.G. 1995. The exploitation of marine molluscs in the Mesolithic of western Scotalnd: evidence from Ulva Cave, Inner Hebrides, in A. Fischer (ed.) *Man and the sea in the Mesolithic*, Oxford: Oxbow books, 273-288

Tolan-Smith, C. 2001. *The caves of mid Argyll. An archaeology of human use*. Edinburgh: Society of Antiquaries of Scotland

Wickham-Jones, C. 2003. The tale of the limpet, *British Archaeology* 71, p23

Woodman, P.C., Anderson, E. and Finlay, N. 1999. *Excavations at Ferriter's Cove 1983-1995: last foragers, first farmers in the Dingle Peninsula*. Bray: Wordwell Ltd