3.4 Worked bone from Sand | Karen Hardy

3.4.1 Introduction

A total of 67 pieces of worked bone has been recorded from the project as a whole. Most of the bone tool artefacts came from Sand (SFS 4) but some were found at other sites and information on them is given in the data report for each site (see Table 107, below; Section 2.2). This discussion concentrates on the 53 artefacts from Sand.

Table 107

Site	Number of tools
Sand (SFS 4)	53
Allt na Criche (SFS 68)	2
Allt na Uamha (SFS 10)	1
Camusteel 2 (SFS 77)	1
Church Cave (SFS 17)	1
Crowlin 1 (SFS 2)	1
Loch a Sguirr 1 (SFS 8)	3
Rubha Chuaig (SFS 58)	3
Toscaig 2 (SFS 20)	1
Uags (SFS 105)	1
Total	67

Table 107: Bone tools

In addition to the bone tools, four pieces of antler tine from Sand have what appear to be cut marks on them. These occur across the midden, with two pieces from square B25A, one piece from B1A and one piece from B3A. All pieces come from Context 13. All have transverse cut marks running across the tines. No tools of antler were found so it is possible that these 'cuts' relate to blunting down or smoothing of sharp edges of stone tools. It is also possible, however, that the processing of antler and main deposition of antler waste took place away from the midden so that these pieces might provide the only hint that tools of antler were used.

Most of the tools found were bevel ended tools; however, a number of other tool types were also represented. In addition, small flakes of bone with apparent flaking characteristics were recognised during excavation at Sand and recorded separately.

Although there was no detailed study of these, it would seem that people were making bone tools at Sand as well as using them. The technology of bone tools in the Mesolithic is still little studied (Foxon 1991), but there is clear scope for expansion in our understanding of bone tools in much the same way that lithic studies have developed over recent decades.

3.4.2 Distribution of Tools

3.4.2.1 Sand

Of the 53 bone tools from Sand, most were bevel ended but a fragment of harpoon and a possible knife were also found, as well as seven bone points (see Table 108, below). Of these 53 tools, five tools, all bevel ended, came from the 1999 test pits and they have been excluded from the discussion on artefact distribution.

Table 108

Sand: Bone Tool types	Numbers of tools
Bevel-ended	42
Knife	1
Harpoon fragment	1
Point	4
Indeterminate (broken)	5
Total	53

Table 108: Sand, Bone tools

The distribution of worked bone across the midden shows that tools are found across the whole excavated area with more items found in area B1, the area with the main concentration of midden (see Table 109, below).

Table 109

Sand: Areas	Nos of tools	
A	10	(21%)
B1	19	(39%)
B2	9	(19%)
B3	10	(21%)
Total	48	(100%)

Table 109: Distribution of bone tools, Sand; (Only artefacts excavated in 2000 included)

The distribution of artefacts through the contexts (see Table 110, below) shows that most were found in the main shell midden, or the topsoil immediately overlying it, with very few outside of this. This may well relate to patterns of discard, but it is also likely to have been influenced by the general lack of preservation of bone away from the midden environment.

Table 110

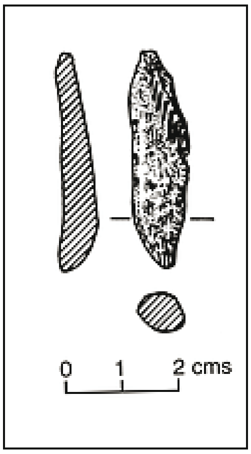
Sand: Context Description	Context Numbers	Area	No of worked bone
Topsoil and turf	1, 1/2, 1/3	ALL	12

Main shell midden	13, 11, 12, 13/23, 13/24, 13/23/24, 24	B1, B2, B3	26 (+ 4 pieces of cut antler)
Shell midden	28	A	2
Slumped stony deposit between midden and sandy soil	27	A	0
Sandy soil with heat cracked stone	17, 29, 17/27	A	5
Palaeo-channel and below	5, 14, 14/21	B3	0
Slopewash over palaeo-channel	7/8	B3	0
Lower organic rich silt (below midden)	22	A & B3	3
Natural	21, 26, 25	ALL	0
		Total	48 (52)

Table 110: Bone tools by context, Sand; (Only artefacts excavated in 2000 included)

3.4.3 Tool Types

Points



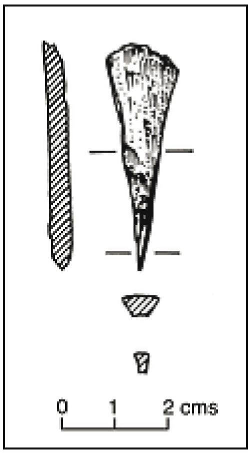
Illus 395: Sand – B2B SE 11. Tool No 22

3.4.3.1 Triangular points

Three long triangular points were found at Sand (see Illustration 394, right). One (BT22) is unusual in that it has a point at each end, but the points lie at right angles to each other (see Illustration 395, left). One (BT65) appears to be unbroken and has visible polish over its pointed end. BT115 is a broken piece with a thick triangular cross section and a long triangular point at one corner; it has no visible polish.

Illus 394: Triangular points (from left to right) – SFS 4; BT115, BT22, BT65)

3.4.3.2 Fine points



Illus 396: SFS 105 – fine point, Tool No 134

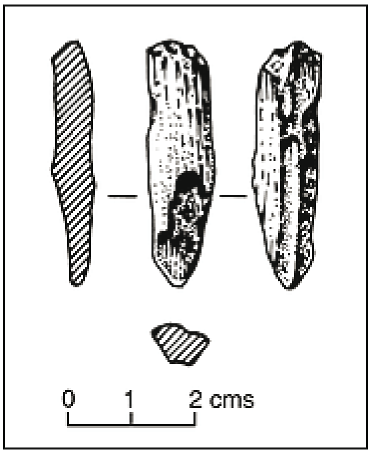
There was one small fine point from Sand (BT56, B1BNE Spit 4, Context 24). It has been carefully made on a small round piece of bird bone. There were, in addition, five other bone points from the survey sites, though they were made on a range of different bone types (see Illustrations 396, lower left & 89, lower right), and had little in common beyond their long, fine points (see worked bone catalogue). All of the points were examined microscopically and only one point (from SFS 68, Allt na Criche, BT 133) was found to have evidence of use. This piece had a rounded end and step fractures on its tip, observable at 40 magnifications, suggesting a light percussive motion. The other pieces (BT132, SFS20; BT135, SFS17; BT134, SFS 105; BT136, SFS 58) had very sharp tips. Though these points have no visible evidence of use (see below) and probably represent pieces that were accidentally discarded, they appear most likely to have been made as piercers of some sort. Their location

Illus 89: Fine points (from left to right) – SFS 58 (BT136), SFS 105 (BT134), SFS 20 (BT132), SFS 17 (BT135), SFS 68 (BT133)

in shell middens suggests that they may be linked to winkle removal; however they could also have been used as bodkins.

There are plenty of periwinkles at many of the sites and, in order to remove meat from the shells, it is necessary either to break the shell or use a pointed instrument. None of the sites has any evidence for the breakage of winkle shells, yet there is also an absence of obvious pointed pieces likely to have been used for winkle extraction. The question of how these shellfish were exploited is thus pertinent. The lack of tools suggests that expedient use of fish or bird bones may have taken place, though it is possible that deliberately made points such as those discussed above were also used.

3.4.3.3 Indeterminate or broken



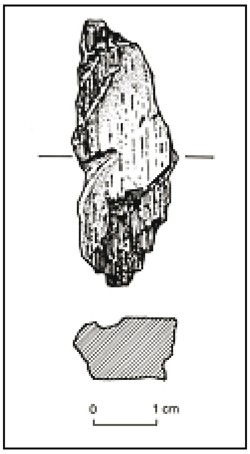
Illus 398: Sand – B25B 12, Tool No 12 showing broken shaft

Additionally, five pieces from Sand were classed as indeterminate or broken. All have wide, flat triangular shaped points (BT12, BT37, BT64, BT69, BT111 (see Illustration 397, right) and were made on long bones; several have evidence of breakage across the shaft (see Illustration 398, left). It is not clear whether they represent a discrete group of points or whether they are proximal portions of broken bevel ended tools.

Illus 397: Sand – indeterminate bone points, BT12, BT64, BT37, BT69

3.4.3.4 Harpoon

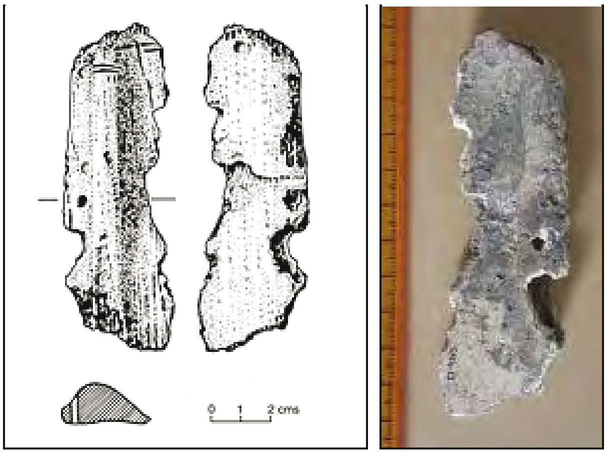
One fragment of harpoon was found at Sand (BT106, B3B SW, Spit 5, Context 13; see Illustration 399, right). This piece was found at the outer edge of the midden. It is a piece of the outer part of the head of the harpoon and it contains one diagonal indentation (see Illustration 400, far right). As the piece is small and fragmentary, it is not possible to identify the species used, nor to say whether it broke during manufacture or use. Harpoons occur on a number of Mesolithic sites across Scotland and can be uniserial, with one side barbed, or biserial with both sides barbed (Bonsall & Smith 1990; Smith & Bonsall 1991). The fragment of harpoon found at Sand is too small to be able to determine its type though Saville (2004c) suggests that most examples from Scotland are biserial.



Illus 399 & 400: Harpoon fragment, B3B SW 13, Tool No 106

3.4.3.5 Possible Knife

One piece of scapula seems to have been deliberately shaped (BT32, B25B SW Spit 6, Context 11/13; see Illustrations 401 & 402, both left). Although it has been broken recently, parts of the original edge remain. No definite use-wear could be observed microscopically, though fine lines exist along the sharp edge that may be related to use. A small amount of deep scratching perpendicular to the edge may or may not be



Illus 401 & 402: Possible knife. B25B SW Spit 6, Context 11/13, Tool No 32

deliberate. There is a small hole in the upper part of the artefact that may be artificial, and if so could have been related to hafting. It lies adjacent to a break in the bone that might relate to another small hole. There was, however, no polish or any other evidence of wear linked to the holes that could be detected either macro or microscopically. It is not clear whether this piece is actually a tool, but it is blade-like in shape and may well have been used.

3.4.3.6 Bevel ended tools

Bevel ended tools occur on stone as well as bone and, occasionally, antler. Current research suggests that the similarity of shape (that is the bevel end) has encouraged tools of stone and bone to be considered as a unity whereas it is likely that they are, in fact, different (Section 3.6). For this reason this discussion considers only tools of bone.

Illus 403: SFS 4, bevel-ended tools (from left to right) – BT4, B25A SW 13; BT2, B25A 13; BT14, B4B NW 1

3.4.3.6.1 Standard bevel ended tools

The bevel ended tools from Sand are formed from ungulate long bones. It was not possible to be specific as to species of the individual tools. They are elongated tools that have a rounded end at one or both extremities. Bevel ended bone tools tend to be associated with midden sites, though this may be a factor of preservation, and they have a wide age range in Scotland. Directly dated specimens go back to 7580–7180 BC at Druimvargie (OxA-4608, Bonsall *et al* 1995) while the most recent dates relate to a tool from Tiree, 1410–1080 BC (OxA-7887; Saville 1998b). Their function has been the subject of long standing debate (for example Connock *et al* 1992; Finlayson 1995; Bonsall 1996; Griffitts & Bonsall 2001).

Illus 404: SFS 4, bevel-ended tool BT30, B25B NE, 13

A total of 42 bevel ended pieces occurred at Sand (SFS 4). In addition there were three from Loch a Sguirr (SFS 8; also dated to the 7th millennium BC; Section 4) and they have been included in this discussion.

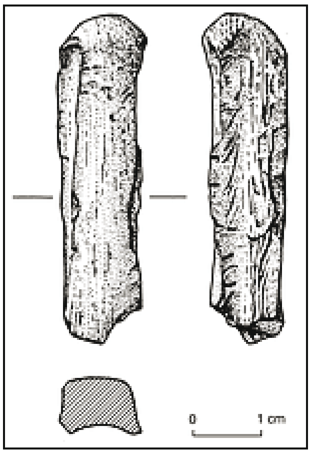
Bevel ended tools can be divided according to whether they are single ended, double ended, a bevel at one end and a point at the other, or indeterminate (see Table 111, below far right) (see Illustrations 403, upper left; 404, lower left; 405, below left; 406, below middle & 407, below right).

Table 111

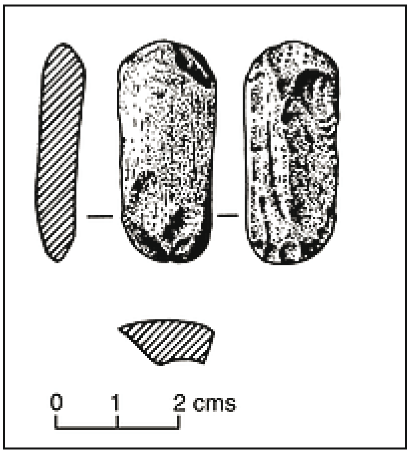
Tool types	Numbers of tools
Double bevel ended	3

Bevel and point	15
Single bevel	21
Broken or indeterminate	6
Total	45

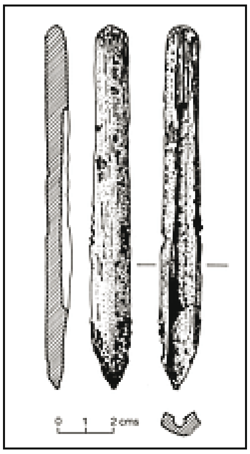
Table 111: SFS types of bevel ended tools



Illus 405: Single bevel-ended tool. B25A NE 13, Tool 3



Illus 406: Double bevel-ended tools, B4B NW Spit 3, Tool 14



Illus 407: Bevel and pointed tool. B25B NE 13, Tool 30

In general, the sides of bevel ended tools can either be straight or tapered (see Illustration 403, above). Two thirds of the bevelled and pointed pieces have tapered sides, leading to the point, while most single and all double bevelled pieces have straight sides (see Table 112, below). Bevel and pointed tools are on average wider, thinner and longer than single and double bevel ended tools (see Table 113, below). Together the morphological differences suggest that different blanks were used to create these different tool-types. Some bevel ended tools from other Mesolithic sites appear to be reused pieces of larger bevel ended tools or tools of other types such as harpoons (Saville 2004c), but this was not observed at Sand.

Table 112

	Single bevelled	Double bevelled	Bevel and point
Straight sides	16	3	4
Tapered sides	5	0	11

Table 112: morphology of the sides of bevel ended tools (only unbroken pieces included, n=39)

Table 113

Average size	Single bevel-ended (N=21)	Double bevel-ended (N=3)	Bevel and point (N=15)
Length	40.1	33.8	52.7
Width	13.4	13.6	14.2
Thickness	8.8	7.0	6.5
Length:width	2.9	2.48	3.83

Table 113: size of bevel ended tools in millimetres (only unbroken pieces included, n=39)

Among the bevel ended tools studied the double bevel ended pieces were generally squat, slightly wider on average than the single bevel ended tools, and on pieces of bone that are slightly thicker than the bevel and pointed pieces (see Table 113, above). This suggests that the small bevel ended tools from Sand are unlikely to have been reworked from larger pieces, as the blanks on which they were made are a different shape to the others.

The actual bevelled end can be either straight across or it can incline to one side or the other. Bevels can occur either on the dorsal or ventral surfaces of the bone (see Table 114, below). The position and angle of the bevel can help to elucidate use. Single bevel ended tools at Sand were more likely to be used on the dorsal surface and incline to the right (see Table 115, below), though some were used straight, thus causing the bevel to form in the middle. Bevel ended and pointed tools were used almost equally on both dorsal and ventral surfaces and the bevel is more commonly inclined to the left. The sample size is too small for detailed interpretation of these differences, but the difference suggest that it is worthy of further research, to elucidate, for example, the possible effect of handedness.

Table 114

	Dorsal	Ventral	Dorsal and ventral
Double bevel ended	2	1	0
Single bevel ended	16	6	1
Bevel-ended and pointed	6	7	0

Table 114: placing of bevel (only unbroken pieces included, n=39)

Table 115

	Left	Right	Middle
Double bevel ended	1	0	2
Single bevel ended	3	10	10
Bevel ended and pointed	8	3	2

Table 115: Angle of bevel (only unbroken pieces included, n=39)

The distribution of bevel ended tools mirrors that of all the bone tools. They are found in all areas but there is a concentration in area B1 and in the main shell midden (see Tables 116 & 117, below).

Table 116

Sand 2000: Areas	Nos. of tools
A	8
B1	15
B2	6
B3	8
Total	37

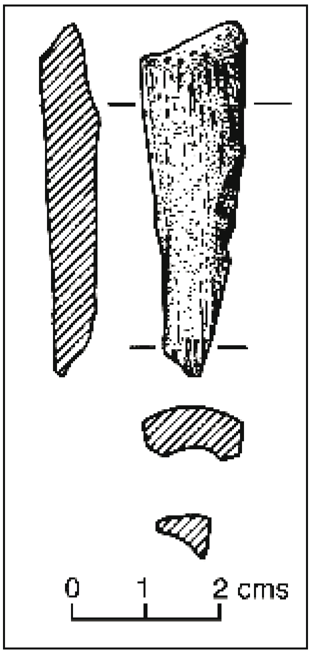
Table 116: Distribution of bevel ended tools, Sand; (Only artefacts excavated in 2000 included)

Table 117

Sand 2000 Context Description	Context Numbers	Area	Bevel ended tools
Topsoil and turf	1, 1/2, 1/3	ALL	10
Main shell midden	13, 11, 12, 13/23, 13/24, 13/23/24, 24	B1, B2, B3	19
Shell midden	28	A	1
Slumped stony deposit between midden and sandy soil	27	A	0
Sandy soil with heat cracked stone	17, 29, 17/27	A	4
Palaeo-channel and below	5, 14, 14/21	B3	0
Slopewash over palaeo-channel	7/8	B3	0
Lower organic rich silt (below midden)	22	A & B3	3
Natural	21, 26, 25	ALL	0
		Total	37

Table 117: Bevel ended tools by context, Sand; (Only artefacts excavated in 2000 included)

3.4.3.6.2 Non-standard bevel ended tools



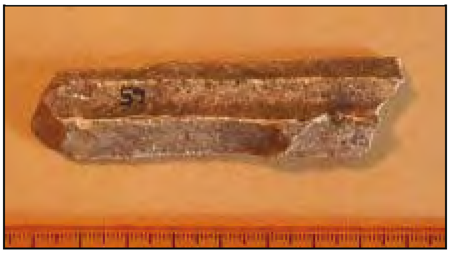
Illus 408: Concave-ended tool. A2B NW Spit 9, Tool No 63

Five pieces have been classified as non-standard bevel ended tools. Four are from Sand and one, from Loch a Sguirr (SFS 8), has also been included here.

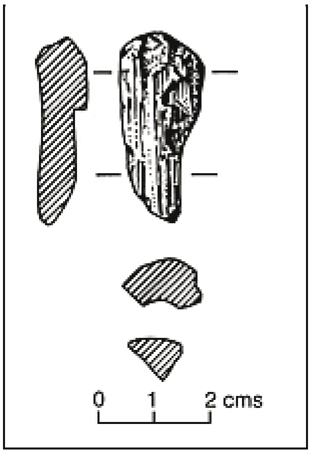
BT63 (Sand, A2B NW Spit 9 Context 22) is unusual in that it has a bevel that is concave rather than the normal convex (see Illustrations 408, left & 409, upper right). This suggests that it may have served a different purpose. Microscopically, the bevel surface was covered with fine horizontal lines, something that was not seen on any other piece.

BT59 (Sand, B25A SE, Spit 4, Context 13) is a large piece that is of the standard single bevel ended tool shape (see Illustration 410, lower right). The distal end has clearly been rounded into the shape of a bevelled tool, however no bevel exists. Instead two large flakes have been removed from the inside (ventral) face. This appears to be an artefact that has been shaped ready for use, but has not been used. It gives an insight into the way bevel ended pieces may have been manufactured; suggesting that the ends were roughly shaped by flaking

Illus 409: Concave-ended tool. A2B NW Spit 9, Tool No 63



Illus 410: Pre bevel, BT59, B25A SE 13

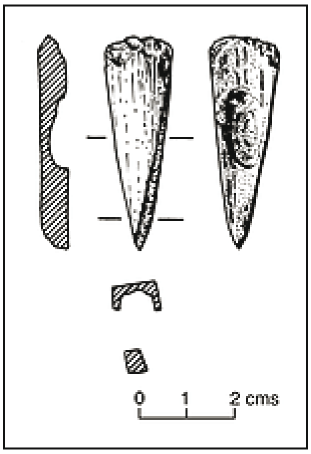


Illus 411: Possible reworked bevelled tool, B2A SE 13, Tool No 38

Illus 412: Possible reworked bevelled tool, B2A SE 13, Tool No 38

before use.

Artefact BT90 (Sand B25A NE Spit 8 Context 13) is a small distal piece of tool that may have been formed to a bevelled shape.

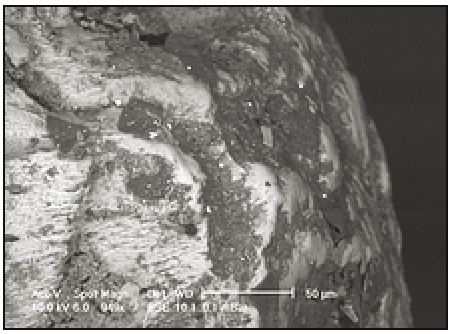


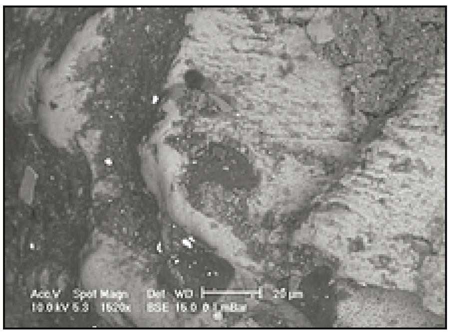
Illus 413: Loch a Sguirr – bevel-ended tool, Tool No 1

Illus 414: Loch a Sguirr – bevel-ended tool, Tool No 1

Artefact BT38 (Sand, B2A NE Spit 4, Context 13) is interesting (see Illustrations 411 left & 412, right). Its proportions are different to other pieces, being as wide as an average bevel and pointed piece but as short as an average double bevel ended piece. It has been roughly flaked at its distal end, and microscopically, it is possible to see that the flaking has eaten directly into a pre-existing bevelled end. It is possible that may be an example of a piece whose bevel had reached the end of its useful life and it was in the process of being reworked.

Artefact BT1 (Loch a Sguirr, SFS 8) has been radiocarbon dated to 6230–6000 BC (OXA-9255; Section 4). It appears to have been highly polished over its ventral surface and is almost symmetrical in shape with a long tapering end (see Illustrations 413, lower far left & 414, bottom right). Its form suggests that it was made with extreme care, far more so than other bevel ended pieces. On its distal end, it also has numerous small flake removals on both dorsal and ventral sides. This tool was examined using a scanning electron microscope (SEM). The fascinating result is illustrated (see Illustrations 415 & 416, both below) and clearly shows the onset of rounding across all the prominent tips of the flake scars. This suggests that bevels were indeed formed first of all by flaking, contrary to the suggestion by Reynolds (1983) and Foxon (1991) that the bevels were ground into shape before use. As the tools were used, clearly in a rounded, smoothing motion, the flake scars became slowly flattened out until they disappeared completely and the rounded bevel that is commonly found was produced. This suggests that the artefacts found in middens may represent bevels that have been used, perhaps to exhaustion.





Illus 415 & 416: SEM image (760× magnifications) of bevelled end of tool BT1 from Loch a Sguirr, showing rounding

Background

In order to try to throw some new light on the use of bone bevel ended tools, an experimental programme was undertaken to investigate both the possible manufacturing techniques and tool use. These tools occur on many Mesolithic sites along the west coast of Scotland (for example Connock *et al* 1992; Mellars 1987; Anderson 1898; Hardy *et al* forthcoming), and questions as to their use have been intensely debated for over 100 years (Anderson 1898; Bonsall 1996; Finlayson 1995; Griffitts & Bonsall 2001; Lacaille 1954). They have long been described as limpet hammers (Bishop 1914; Griffitts & Bonsall 2001), and this interpretation gained support from the fact that they only occur in shell middens, though there are other theories, one of which suggests that bevel ended tools were used to process animal hides (Foxon 1991; Finlayson 1995).

3.4.4.1 Experimental replication and use of bevel ended bone and antler tools

Illus 417: Fresh roe deer legs ready for use

Bevel ended bone tools are normally manufactured from splinters of bone, many of which have been identified as the metapodia of red deer (Saville 2004c). Based on an assessment of the breakage patterns of bone (Outram 2002:53–9), it seems likely that bevel ended tools were manufactured from both fresh ('green') and older bone, (see also Section 3.11).

Illus 418: Roe deer (fresh) and red deer metapodia (2 years old)

Prior to the experimental programme, metrical and morphological data were collected from various archaeological tools using a Leica Wild M28 Microscope at 10× and 20× magnification to look for traces of manufacture (flaking and cut marks), evidence of hafting and use-wear traces including striation marks, grooving and polish (Birch 2003).

A total of 28 'modern' tools was made using a mix of fresh red and roe deer leg bones (metapodia), as well as 'seasoned' two year old red deer bone (see Illustrations 417, left & 418, right); two year old red deer antler was used for the antler tools (see Table 118, below). Subsequently, 14 tools were used experimentally; five of antler and nine of bone.

Table 118

Tool No	Material	Reduction Method	Bevel Preform Method
1	Bone	Direct Percussion	Direct Percussion
2	Bone	Direct Percussion	Indirect Percussion
3	Bone	Wedge-Splinter	Direct Percussion
AT3	Antler	Groove & Splinter – Burin Tool	Corners rounded by grinding
4	Bone	Direct Percussion	Direct Percussion
6	Bone	Wedge-Splinter	Indirect Percussion
6	Bone	Wedge-Splinter	Indirect Percussion
7	Bone	Direct Percussion	Indirect Percussion
AT7	Antler	Groove & Splinter – Burin Tool	None

AT8	Antler	Groove & Splinter – Burin Tool	None
AT9	Antler	Groove & Splinter – Burin Tool	None
AT11	Antler	Groove & Splinter – Burin Tool	Corners rounded by grinding
15	Bone	Grooving Technique	Indirect Percussion
17	Bone	Grooving Technique	Direct Percussion
20	Bone	Direct Percussion	Direct Percussion

Table 118: Experimental tools; Back to Section 3.4.4.7

The experiments were designed to assess tool efficiency and any changes in tool morphology that might occur as a result of use. Tasks were designed to relate directly to the possible prehistoric setting of the Inner Sound. Work focused primarily on shellfish processing and animal skin scraping, though bark stripping and processing plant fibres were also carried out.

3.4.4.2 Primary reduction

Three methods were used to reduce the bone into potential blanks (see Table 118, above).

Illus 419: Bone fragments resulting from direct percussion

- Direct percussion using different sized hammerstones and a stone anvil. This reduced the bone into splinters, many of which served as potential blanks (see Illustration 419, right). This reduction method worked equally well on fresh and older bone. The resulting tool blanks display a similar morphology to the archaeological tools, some of which are tapered at one end. Some of the blanks also retained the epiphyseal or diaphysis end of the bone, similar to some archaeological tools.
- The ‘wedge-splinter’ technique. Here, the metapodia was placed on the anvil stone and a wedge of bone was placed in the anterior groove. This was then struck directly using a large hammerstone. This method was more successful than direct percussion at removing a more uniform blank on fresh bone, but no difference was found between the two methods when working older bone.

Illus 421: Grooving red deer antler with flint burin tool

Illus 420: Bone reduction using grooving and hammerstone

- A third form of bone reduction strategy was also attempted using techniques identified by David (2003: 651–6). This involves the grooving of the metapodia prior to removal of the epiphysis and diaphysis using combinations of dotted perforation, sawing and percussion (see Illustration 420, right). It offers more control over the morphology and size of the blank, and it worked well, but there is, as yet, no direct evidence that it was used in Mesolithic Scotland.

Analysis of the archaeological bevel ended tools manufactured from antler failed to reveal any evidence for a particular reduction strategy. During the experimental manufacture of antler tools however, control of the antler blanks was found to be almost impossible without prior grooving using a flint burin (see Illustration 421, left), though in reality burins were not found on any of the excavated sites and are indeed rare in the Scottish Mesolithic. The problems of working antler blanks could be reduced by soaking the raw material in water for up to five days prior to work (Wescott 1999:72–3).

3.4.4.3 Secondary reduction

The shaping of the bone blanks into pre-forms was carried out using direct percussion with a pebble hammer, much like striking a flint core. Older bone was shaped very quickly in this way, the brittle nature of the bone making it more suited to the finer finishing processes, but on fresh bone and smaller pieces of old bone indirect percussion was found to give more control. The fresh bone was difficult to work in a controlled manner, mainly due to the presence of fine membranes covering the bone surface and the relatively ductile properties of the bone itself.

To shape the bevel preform and working edge of the tool, a series of rough flakes were first removed in order to give a basic shape to the tool, and smaller flakes were detached to finish the piece. As in working flint, subsequent flake removals tended to follow previous scars. For the indirect percussion a sturdy flint flake that had been blunted at the tip was used as a punch in conjunction with a small hammerstone. Using these methods a sharp chisel edge could be manufactured which displayed very similar morphology to the archaeological tools that had not been subsequently rounded through use (see Illustration 422, right).

Illus 422: Tool AC50 from An Corran showing flaking

Due to a lack of evidence for any preliminary working of the antler blanks, the majority of the replicated antler tools were used experimentally without modification. If a bevel preform was required for a specific experimental task, such as that used to scrape animal skins or to remove tree bark, the bevelled edge could be created by first rubbing the end of the antler blank on a rough stone or pebble. The sharp corners of antler blanks could also be rounded with this method, to stop them puncturing the materials.

3.4.4.4 Tool hafting

It is unclear whether bevel ended tools were hafted. For the purpose of this study some tools were hafted (see Table 119). Hafts were made of bone, antler and wood (see Illustration 423, right). After use, tools were examined for damage or wear that could be related to hafting. At 20× magnification some of the bone tools showed areas of weak glossy polish on the proximal end of the tool, similar to use-wear traces observed on some archaeological tools.

Illus 423: Antler tool in hazel haft

Table 119

Tool No	Hafted / Not Hafted	Tool Use
1	Not Hafted	Scraping wet limpet shell
2	Hazel Handle	Breaking down nettle stems into fibres
3	Bone Metapodia haft	Scraping wet limpet shell
AT3	Antler Beam Handle	Removing pine bark from tree trunk
4	Antler Beam Handle	Detaching limpets from rocks
6	Hazel Handle	Scraping a fresh wild boar skin
6	Hazel Handle	Scraping a dry red deer skin
7	Not Hafted	Grinding down sorrel leaves
AT7	Hazel Handle	Scraping wet limpet shell

AT8	Antler Beam Handle	Removing limpets from rocks
AT9	Hazel Handle	Extracting limpet meat from shell
AT11	Antler Beam Handle	Scraping a dry red deer skin
15	Not Hafted	Scraping wet limpet shell
17	Not Hafted	Extracting limpet meat from shell
20	Not Hafted	Removing birch bark residues

Table 119: Experimental use of bevel ended tools

3.4.4.5 Experiment 1 – Tree bark processing

Ethnographic evidence and materials recovered from prehistoric sites, especially in Scandinavia (Schilling 1997:94; Östlund *et al* 2004) and South America, have revealed the importance of tree bark in hunter-gatherer communities. Bone tools in Tierra del Fuego for example (Bridges 1949; Scheinsohn & Ferretti 1995), were used to harvest bark from trees, specifically to lever the bark away from the trunk, and to scrape excess residues from the inner face of the bark. The following experiments were designed to replicate these tasks.

Method

Two tools were used; AT3 and 20. Antler tool AT3, hafted in a red deer antler handle, was used to prise bark from a pine tree (*Pinus sylvestris*, see Illustration 424, right & Table 120, below). A bevel was created on the tool before use by rubbing on a rough granite slab of rock. This was done to blunt the sharp corners. Bone tool No 20 was not hafted. It was used to remove resinous residues from the inner face of bark removed from a birch tree (betula pendula).

Illus 424: Using antler tool to prise pine bark from trunk

Table 120		
Tool No	Tool Use	Time in Use
AT3	Removing pine bark	25 mins
20	Birch bark residues	120 mins

Table 120: Tree bark processing

Tool Efficiency

AT3 was very effective at stripping continuous runs of pine bark from the trunk; a 7.5m length was extracted during this experiment. Few holes were punctured through the bark, most of these occurring where side branches were located. The tool was used for 25 minutes. Bone tool No 20 was efficient at removing the hard resin deposits from the inner face of the birch bark while it retained a sharp, chisel edge. However, the efficiency reduced dramatically as the tool became blunted through use (the tool was used for 120 minutes).

Results

The replicated antler tool (AT3) was effective at removing pine bark from the trunk and use-wear was slow to develop. The tool dimensions had not changed after the experiment, though the tool bevel had taken on a slightly convex profile. The working edge of the tool was still quite sharp, while the corners of the tool had blunted and taken on a slight polish. At 20× magnifications a limited amount of polish was visible down the sides of the tool, away from the working edge. The striations on the ventral face run parallel with the axis of the tool, while those on the dorsal face run diagonally across the bevel.

Bone tool No 20 showed slight bevelling after two hours of use on the birch bark, and its working edge was slightly convex in profile. Under low magnification a high gloss polish could be seen on the high points of the bevels with faint striation marks running at 90° to the tool edge. The bevelling of the tool through use was starting to obscure the initial flaking. With more time it is likely that a bevel form similar to those observed on the archaeological specimens could be replicated.

3.4.4.6 Experiment 2 – Plant Processing

It is possible that tools manufactured from bone and other materials may have been used to process plant materials during the Mesolithic. However, the limited evidence available for plant use during this time meant that the experimental programme was based on speculation rather than direct evidence.

Method

Illus 425: Tool No 2 in use on nettle stems

Illus 426: Processed nettle stems

Two experimental bone tools (Nos 2 & 7) were used for these experiments (see Table 121, below). Tool No 2 was hafted in a hazel handle and was used to break down nettle stems into fibres. An anvil stone of granite was used to support the plant stems, while the bevel ended tool was used at both ends, to run down the stem of the nettles, separating the fibres (see Illustration 425, left). A total of 22 nettle stems was processed, some of which were quite old and 'woody' (see Illustration 426, right). The experiment lasted for 80 minutes. Tool No 7 retained the articular end of the red deer metapodia and that proved a useful handle. The tool was used for 60 minutes to pulverise and grind sorrel leaves into a paste.

Table 121		
Tool No	Tool Use	Time in Use
2	Nettle stems/fibres	80 mins
7	Grinding Sorrel leaves	60 mins

Table 121: Plant processing

Tool Efficiency

Tool No 2 reduced the nettle stems to individual fibres effectively, while Tool No 7 was not efficient at processing the sorrel leaves into a paste, but did succeed in shredding the material.

Results

The use of tool No 2 resulted in a sharp and pronounced working edge with slightly convex bevels. The corners of the tool show little rounding, while the visible striations on the bevels are multi-directional. Both bevels are lightly polished. This polish extends for a short distance down the tool edges. An examination of the tool where it had been retained in the hazel handle shows light polish to high spots along the edges.

Tool No 7 had no clear wear pattern, though new striation marks were observed on the bevel faces, both of which were used in the experiment.

The final shapes of the bevels on these tools were quite unlike those observed on most archaeological tools. However, it is possible that this may be due to the relatively short duration of the experiment.

3.4.4.7 Experiment 3 – Shellfish Processing

Bevel ended tools have long been linked to shellfish collecting and processing. (Anderson 1898; Bishop 1914; Lacaille 1954; Mellars 1987; Bonsall 1996; Connock *et al* 1992; Finlayson 1995; Griffitts & Bonsall 2001; Birch 2003). Although the primary aim of the experiments was to assess the effectiveness of the tools in processing limpets, both in removing limpets from shoreline rocks and scooping meat from the shells, the use of the tools in a realistic environment also highlighted some of the difficulties inherent in limpet harvesting and processing.

Limpet harvesting and processing experiments were undertaken at Ashaig in Skye, where a sandy foreshore with numerous rocky reef structures, provided ideal conditions for limpet collection at low tide (see Illustration 427, right). All limpets harvested were subsequently used as bait.

Illus 427: Limpets attached to foreshore rocks at Ashaig, Skye

Method

Five bone and three antler tools were used (see Table 118, above). One coarse pebble tool was also used to remove limpets from the shoreline rocks, to compare the efficiency of stone with bone and antler (Experiment 3D below).

Experiment 3A

This experiment replicated the work undertaken by Griffitts & Bonsall (2001). Empty limpet shells, dipped in water, were scraped round their insides in a laboratory setting, in order to replicate the scooping motion understood to be the action required to remove limpet meat from its shell (see Table 122, below). Their other experiment, which involved holding an empty limpet shell against a flat surface with one hand while striking it with another, was not replicated.

Table 122

Tool No	Tool Use	No of Actions
1	Scraping wet limpet shell	1000 scoops
3	Scraping wet limpet shell	1000 scoops
15	Scraping wet limpet shell	3200 scoops
AT7	Scraping wet limpet shell	1400 scoops

Table 122: Wet limpet shell experiments

Experiment 3B

Antler and bone tools were used at Ashaig beach, Isle of Skye, to detach limpets from the shoreline rocks. It was found necessary to use hafts of red deer antler for the tools in order to provide the force required in completing this action. The most efficient technique required to remove the limpets is to strike with the tool, held at around 45 degrees to the rock surface, at the interface where the limpet shell is attached to the rock. Limpets were most easily detached when they were freshly exposed as the tide receded (see below).

Experiment 3C

Bone and antler tools were used to remove (scoop) limpet meat from the shell at Ashaig, Skye (see Illustration 428, right).

Illus 428: Bone Tool No 17 and extracted limpet meat

Illus 429: Sandstone pebble tool used to detach limpets at Ashaig

Experiment 3D

A coarse sandstone pebble tool (9.5cm long × 4.5cm wide, max × 3.8mm thick), similar in form to the stone bevel ended tools recovered from several Mesolithic shell midden sites (for example Mellars 1987; Mithen 2000), was used to detach limpets from shoreline rocks. The pebble had a naturally rounded end and was picked up on the foreshore at Ashaig, Skye. It was used without any prior modification (see Illustration 429, left).

Tool Efficiency

Experiment 3A. This experiment did not provide any useful data to complement the findings of this study, probably because it was undertaken in simulated laboratory conditions. Work with live limpets (see Experiment 3C) showed that the type of action required to remove the meat from a limpet shell was quite different from that inferred by the simulation. Nevertheless, the use-wear on all of the tools used for this experiment produced rounded bevels similar to the archaeological tools. The bevels were convex in profile and highly polished, with shallow multi-directional striations. The polish extended down the edges of the tool from the bevel edge.

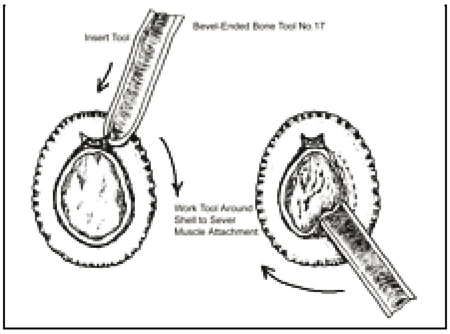
Experiment 3B. Bone tool No 4 was hafted in a piece of red deer antler beam and used to detach limpets from the shoreline rocks (see Table 123, below). After successfully removing five limpets, the tool was so badly damaged that it was no longer usable. Flakes of bone were detached through use from the working edge of the tool and the resulting bevel morphology was quite unlike that observed on archaeological tools. There was heavy and deep grooving visible on the bevels. The antler tool used for this experiment (AT8) was hafted in a section of red deer antler beam and was found to be very effective at removing limpets from the rocks, removing 700 shells in 45 minutes of foraging with a 95% strike rate. Very few limpets were damaged during this process.

Table 123

Tool No	Tool Use	Time in Use	No of Actions
4	Detaching Limpets	*4 mins	5 Limpets
AT8	Detaching Limpets	45 mins	700 Limpets
Pebble	Detaching Limpets	30 mins	350 Limpets

Table 123: Experiments 3B & 3D, Detaching limpet shells from rocks
NB: * Tool no 4 was damaged beyond further use after only five minutes

Experiment 3C. One bone tool (No 17) and one antler tool (AT9) were used to extract limpet meat from the shell (see Table 124, below). Tool AT9 was used to extract 230 limpets and this was achieved in 15 minutes. The width and thickness of the antler tool made it difficult to extract the



Illus 430: Method used to extract limpet meat

meat without damage and the side edges of the tool provided the cutting action required to sever the muscle attachment of the limpet. Bone tool No 17 was a better shape and very effective at removing meat, with 1100 limpets extracted in around 60 minutes (550 removed using each side/bevel of the tool). To remove a limpet the bevel of the tool is pushed between the meat and the shell at a point to one side of the muscle attachment. A circular motion is then used around the inside of the shell to detach the meat, including the muscle that attaches the meat to the shell (see Illustration 430, right). This process requires some force, especially if the tool bevel and edges are blunt. Using this method the limpet meat came out of the shell clean and undamaged.

Table 124			
Tool No	Tool Use	Time in Use	No of Actions
17	Limpet meat extraction	60 mins	1100 meats
AT9	Limpet meat extraction	15 mins	230 meats

Table 124: Experiment 3C, Limpet meat extraction

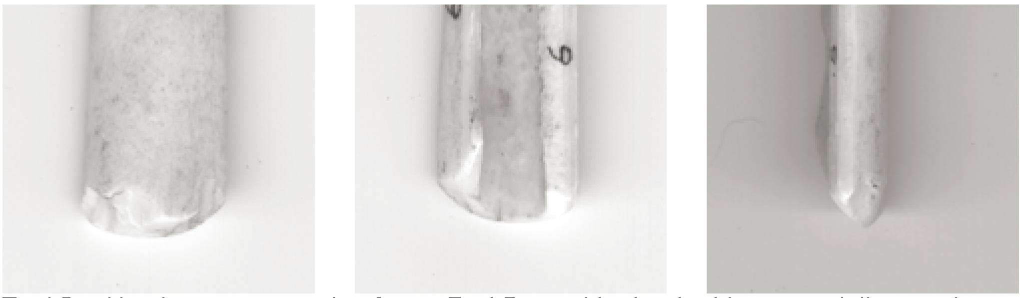
Illus 431: Limpets harvested using the unmodified pebble tool

Experiment 3D. The small unmodified elongated sandstone pebble used for this experiment was very effective at removing limpets from rocks, using a sharp tap at the junction of the shell and rock (see Illustration 431, right). Three hundred and fifty limpets were harvested during 30 minutes of foraging time, with a 98% strike rate. Only five limpets were damaged. There was also less impact generated through the body of the tool to the hand than experienced using the antler and bone tools.

Results

Harvesting limpets

The results suggest that it is unlikely that bevel ended bone tools were used to detach limpets from the shoreline rocks as they were ineffective for this work. However, antler tools mounted in antler beam handles were quite effective, though the impact shock transmitted to the hand of the user made working uncomfortable, and stone may have been a better medium. The harder, dorsal face of the antler was best for this task. Tool AT8 displayed a rounded profile (see Illustration 432, below) and convex bevels after use. The corners of the tool were also slightly rounded, but the bevel faces showed little polish; they were heavily grooved and pitted, especially on the dorsal bevel.



Tool 6 – Used to scrape and soften a Red Deer skin that had been partially cured

Illus 432: Scanned images of a selection of the replicated and used bevel-ended bone and antler tools (see individual captions in full image for descriptions)

Limpets on ‘clean’ shoreline rocks and on surfaces approaching the horizontal were easier to detach than those attached to rough, barnacle infested rocks with a more vertical angle. Barnacles made it difficult to strike at the interface between the base of the limpet and the rock. Limpets submerged below the surface of the water, such as in rock pools, were also relatively easy to remove.

The state of the tide has a clear influence on the ease of limpet harvesting. Not only does it directly dictate the amount of foreshore that is exposed at any one time, but also it became apparent that the most effective time to harvest limpets was during a spring tide, as the foragers follow the receding waterline. Below water, limpets are not so strongly attached to their rocky home. Between tides, when they are exposed above the waterline, they become increasingly attached to the rocks with time, especially on hot, sunny days. Working with the receding tide, it was rarely necessary to wade into the water in order to detach limpets effectively.

The small, elongated sandstone pebble was easy to procure and use. After use a distinctive bevel was starting to form at the working edge, very similar to those found on archaeological stone bevel ended tools.

Removing limpet meat

The antler tool (AT9) used to remove limpets from their shell formed little visible wear patterning, though the experiment was conducted over a relatively short period of time. The tool was not effective at removing the meat, however, and it caused damage to the product during the process. The bone tool used for this experiment (No 17) though well suited to the task did not develop a pronounced bevel, even after the removal of the meat from 1100 limpets. The small bevel that formed on the dorsal face of this tool is rounded in profile and does not resemble those on the archaeological tools. It is slightly pointed in profile and there is distinctive wear patterning extending down the sides of the tool for approximately 14mm. Shallow striations and areas of weak polish were also observed on the bevel. The absence of a prominent bevel is due to the fact that it is the sides of the tool rather then the end that form the ‘working’ edge. Extraction principally involves cutting through the muscle attachments.

3.4.4.8 Experiment 4 – Hide Preparation

Method

Two experimental tools were used (No 6 and AT11) (see Table 125, below). Tool No 6 was hafted in a hazel handle and was initially used to scrape fat and membranes from a fresh wild boar skin (see Illustration 433, right). The skin was not stretched, but was worked on a hard ground surface. The tool was then re-sharpened by flaking with a pebble hammer using direct percussion and was used to scrape dried membrane from a dry, partially cured red deer skin. Tool AT11 was also used to prepare the red deer skin,

Illus 433: Using bone tools on fresh wild boar hide at Lejre

scraping away the dried membrane on the inner face of the skin. The skin did not require stretching due to its rigidity, but was processed as it was laid out flat on hard ground.

Tool No	Tool Use	Time in Use
6	Fresh wild boar skin	50 mins**
6	Dry red deer skin	225 mins
AT11	Dry red deer skin	210 mins

Table 125: Experiment 4, Hide preparation
NB: **Tool 6 re-sharpened after 20 minutes

Tool Efficiency

Tool No 6 retained a sharp chisel edge and was quite effective at removing the meaty and fatty deposits from the fresh wild boar skin. A significant amount of force was required to remove these deposits, however, and after approximately 20 minutes the tool became blunt through use; this affected its efficiency considerably. To retain the tool's effectiveness, regular re-sharpening of the bevel-end was required. The tool was used for a total of 50 minutes on the wild boar skin. Stretching the skin out in a frame would have made this work easier.

Tool No 6 was then re-sharpened and was quite efficient when used on the dry and partially cured red deer skin, especially while a sharp chisel edge was retained (but see Results below). It was used to remove the fine, dried membrane from the inner face of the skin. Both bevels were used for a total of 3 hours 45 minutes without any further modification. Antler tool AT11, mounted in a section of red deer antler beam, also performed this same task effectively and was used for a total of 3 hours 30 minutes, without modification during use. It was necessary to use considerable force to process the red deer skin and the tools lost their useful working edge after 20–30 minutes of use (see Illustration 434, right).

Illus 434: Antler Tool No 11 used on partially cured red deer hide

Results

When used to process the fresh wild boar skin, tool No 6 took on steep, slightly convex bevels, with a dull gloss finish. Striation marks were faint and shallow, and multi-directional on the two bevels at 20x magnification. The tool soon lost its effectiveness on the skin as it became blunted through use, and regular re-sharpening was required. The most common bevel morphology recognised on the archaeological tools, comprising well rounded bevels, would not be effective at removing the fatty deposits from the skin. This suggests that is unlikely that bevel ended tools were used for this particular aspect of skin processing.

Both tools used on the partially cured red deer skin (No 6 and AT11; see Illustration 435, right) quickly lost their effectiveness at removing the dried membranes. However, the processing method used on the skin had unforeseen results, in that the consistency of the skin became more elastic and pliable as the experiment progressed. The tools were effective in this aspect of the process even after their edges became blunt through use, and they were particularly good at removing hard, creased areas from the skin. A 'scoring-type' motion was most effective at performing this task and this resulted in a flexible and supple hide.

Illus 435: Antler and bone tools used on red deer hide

During the experiment new flaking scars appeared on the bevels of tool No 6 near the working edge, and the more general flaking scars from tool manufacture started to be masked by the formation of rounding and polish. The bone tool also displayed areas of polish extending down the sides of the tool at the distal end for approximately 15mm. After the experiments, both replicated tools had distinctive convex bevels similar to those on archaeological tools. The bevels have a high, glossy finish with regular striations running diagonally right to left across their faces. It was found that during use the tool was used to score the hide diagonally, due to a combination of factors including where the operator was positioned in relation to the area of work on the skin and how the tool was manipulated.

The corners of the bevels are thus slightly rounded and polished. Examination of tool No 6 at 20 magnifications and after removal from the hazel handle, displayed areas of polish down the sides of the tool as well, especially on high spots, and this is most likely to be due to movement in the haft during use. Similar polish was observed on many bone tools from the archaeological collections analysed for this work.

3.4.4.9 The results of experiment: discussion

The experimental programme suggests that bone bevel ended tools were not used to process shellfish; they were inefficient at removing limpets from the rock, and while they were useful for extracting limpet meat from inside the shell, the morphology of the resulting bevel did not correspond with the archaeological samples. Antler tools were ineffective in extracting limpet meat from the shells, though they were capable of removing limpets from the rocks. The sandstone beach pebble was excellent for detaching limpets and quickly started to develop bevels that resemble the archaeological material. It seems more likely that stone was used for this in the past.

Exploration of the use of bevel ended tools for plant processing requires further experiment. Both antler and bone tools were effective for these tasks, but only weak use-wear patterns developed in the time allocated. The initial results suggest that bevel ended tools could have had a relatively long and efficient life in tasks such as removing bark and processing plant materials. Antler provides a tough, impact-resistant, material, and these superior qualities make it more suitable for bark removal.

The hide working experiments produced wear patterns and tool morphology similar to those on Mesolithic tools, especially the task of softening skins during the curing process. However, a significant amount of force and pressure was required to remove the fatty tissues and membranes, and this force was impossible to apply using shorter tools. Tools less than 40mm long were not capable of generating the energy required to break down the fibres during the curing process unless they were hafted.

The experiments suggest three possible uses for the tools: bark processing, plant processing and hide working. Of course different tasks may have been carried out at different sites, and other tasks may await detection. Microscopic analysis of the archaeological tools from Sand suggests that hide processing may have been the predominant task there (below). Work on other sites is necessary to refine this interpretation for other places.

Hand lens study

Forty-four bevel ended tools from SFS sites (SFS 4 Sand, & SFS 8 Loch a Sguirr) were examined using a hand-held magnifier (10× magnifications) for use-wear traces on their surface (see Table 126, below).

Table 126	
Longitudinal scratch marks	28
Other types of use-wear (polish etc)	7
Not visible, eroded etc	9
Total	44

Table 126: Wear traces at 10× on bevel ends

Almost two thirds (64%) of the tools had clear, well defined longitudinal scratch marks visible at 10× that ran the length of the bevel perpendicular to the working edge (see Table 126, above). These marks were generally very consistent as to depth and size of scratch. This suggests that most of the tools have been used in the same way and for the same purpose. Seven tools had other types of use-wear, notably polish and transversal scratching, while one tool had evidence of possible percussive activity. Nine tools were too eroded to identify use-wear.

Four of Birch's experimental tools (see Section 3.4.4) were examined in the same way (AT9, AT11, AT8 and AT3). Tool AT11 was the only tool that had longitudinal scratch marks, similar to those on 64% of the archaeological tools. This tool was used to scrape a red deer skin. There is clearly more work to be done, but this does add weight to the possibility that bevel ended tools may have been used for hide working.

Scanning Electron Microscope work

Thirty-seven archaeological tools from a range of Mesolithic sites (see Table 127) were examined using a Scanning Electron Microscope (SEM) with the aim of detecting any residues adhering to the tools and extracting any chemical information that might provide an indicator as to the possible materials worked. In addition six of the experimental tools described above (Birch above) (used on shell, limpet meat, birch bark, wood, hide, and seaweed) were also examined using the SEM. The experimental tools were analysed for organic residues (see below) in order to provide a useful modern analogue to the archaeological material. The individual raw materials themselves were also analysed separately to the tools that had been used to work them.

Table 127	
Sites	Bevel-ended tools analysed
Morton, Fife	1
Druimvargie, Argyll	2
Caiteal nan Gillean I, Oronsay	5
McArthur's Cave, Argyll	5
Sand	10
Loch a Sguirr	1
An Corran, Skye	13

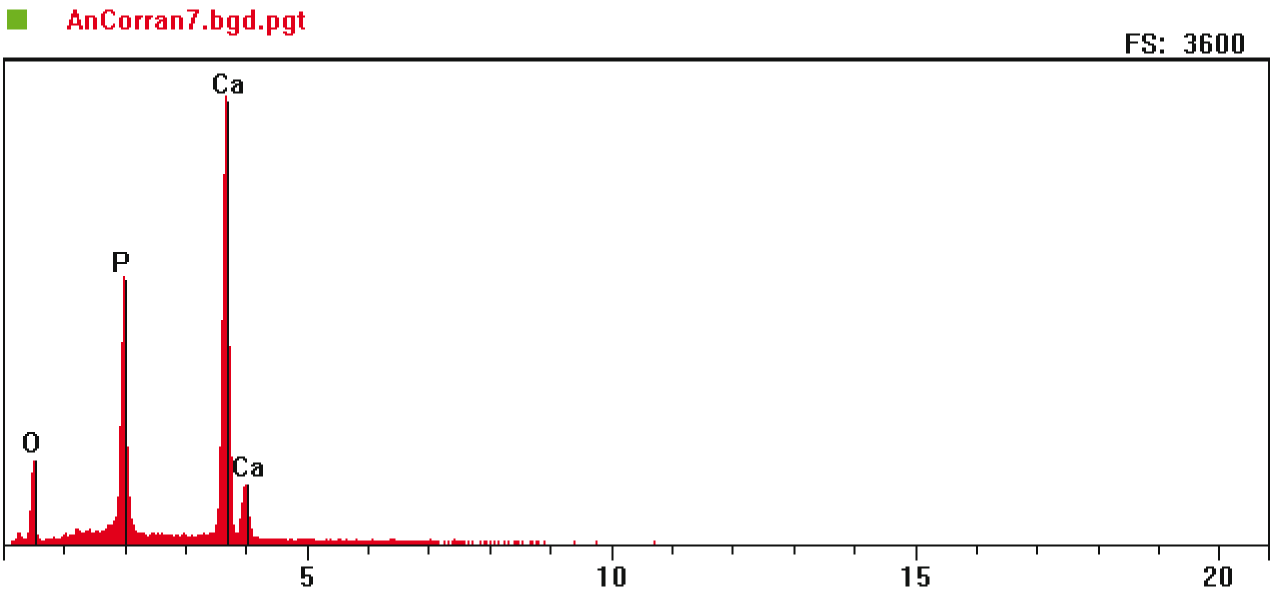
Total	37

Table 127: bevel ended bone tools from Mesolithic sites analysed using the SEM

3.4.5.1 Method

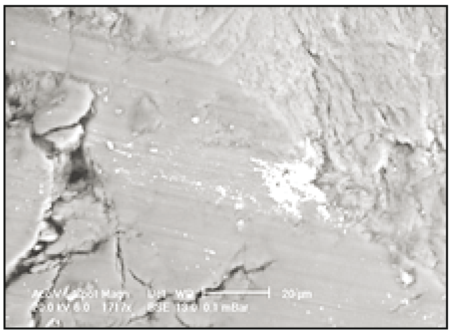
Each artefact was examined across one surface and a series of spectra was taken. The first spectrum for every piece was a background spectrum of the bone surface, without residue, which was used as a control. Following this, further spectra were then taken on representative samples of any residues. Samples were selected based on the ease with which they could be pinpointed (that is their location on the bevel relative to the beam) followed by how representative they were of the residues found across the tool surface. A total of 244 readings was taken across all 37 archaeological tools.

A Philips XL30CP SEM instrument with an analytical system capable of detecting light elements (down to C) was used. Imaging was carried out using back-scattered electron (BSE) mode, and point analyses were made of features on the rough surface of each tool. Analysis was carried out using PGT (Princeton Gamma Tech) analytical software, which provided an energy dispersive (ED) spectrum (see Illustration 436, below) that was used as a fingerprint to distinguish different material types, supported by a semi-quantitative analysis (fully quantitative analyses are impossible with rough samples). A background analysis was made on the residue-free bone surface to permit comparison with spectra and analyses obtained from the residues on the bone. In all cases, the peaks reported in the ED spectrum were identified using the analytical software, taking care to identify and label K_α, K_β, L_α and L_β X-ray peaks when observed.



Illus 436: Example of a background spectra, Tool An Corran 7

Bone tools were manually tilted to place the bevel in focus. This was then examined transversely across a section of the bevel as near to its mid point as possible. Spectra were recorded on a selection of different residue types located across the surface of the tool. At magnification, the surface of the bone ranges from very smooth to fibrous or very fibrous. The areas of very smooth bone are very compact and appear to be polished; even at high magnifications no pock marking was evident. Illustration 437 (right) shows a background of polished bone in the foreground, with a surface mineral residue (showing white), while in the background a more fibrous bone surface can be seen.

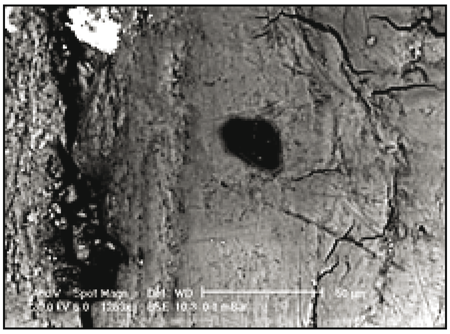

Illus 437: Bone surface with mineral residue. An Corran tool 7 (magnification 1717×. The mineral here is silver ore soil)

Using BSE (back-scatter electron) mode, residues show up as black for organic material and white for mineral material. An interpretation as to the nature of the residue was inferred from the energy dispersive spectra obtained from the SEM (Hardy *et al* forthcoming b).

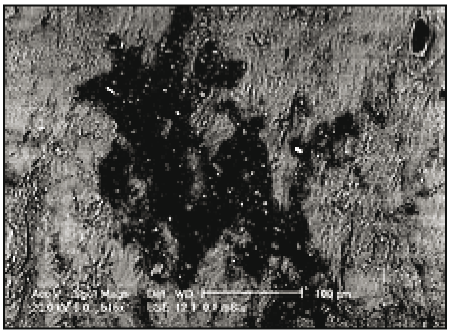
3.4.5.2 Organic residues

One idea was that bevel ended tools may have been used to grind up small quantities of plants, perhaps for medicine or for pigment. In order to characterise organic residues, the relative atomic proportions of carbon and nitrogen are required (Brady 1974). The proportions of nitrogen in relation to carbon in plant tissue are so small that it is clearly distinguished from animal tissue where the proportion is much greater. The atomic proportions of carbon:nitrogen are thus diagnostic of a range of natural materials including:

- Wood, straw, oils and fats = C/N >30
- Green plant tissue = C/N around 25
- Wheat and other seed grains = C/N around 15
- Soil and fungi = C/N around 10
- Animal protein, bacteria and actinomycetes = C/N 5 and below.



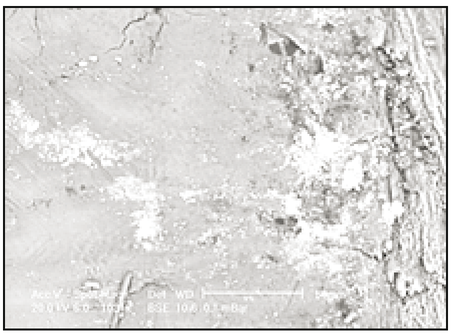
Illus 438: Example of an organic residue, Tool An Corran 10 (magnification 1253×). The residue is the black vertical line with mineral scratch overlying it



Illus 439: Example of an organic residue. Druimvargie 415. Magnification 516×

Though organic residues show up clearly in the SEM (see Illustrations 438 & 439, both right), there is currently no clear consensus as to the reliability of the relative carbon and nitrogen components as read by the SEM. This affected interpretation of the readings taken both on the experimental tools and on the archaeological pieces. While it is not possible without further investigation to allocate the residues to any of the above groupings (wood, soil etc) based on these readings alone, almost all of the organic residues measured on the archaeological bone tools had high percentages of nitrogen, suggesting that they were not of plant origin. An experimental check was carried out with samples of modern birch bark and wood and these all produced readings that showed percentages of nitrogen that were consistently very low as would be expected from plant residues. This indicates that the high proportion of nitrogen in the archaeological samples, though non-specific, is a good indication that their residues are not plant in origin. In the end, though readings were also obtained on the experimental tools, detailed comparative work to attempt to determine actual raw materials using the data obtained from the experimental tools was not undertaken because of the lack of consensus about the validity of the carbon:nitrogen ratios. This is obviously a fruitful topic for further study.

3.4.5.3 Mineral residues



Illus 440: Example of a mineral residue An Corran 7.

As the experimental tools had only been used on organic materials, they are not included in this section. Out of a total of 35 tools with 'white' residues, ten tools contained only spectra interpreted as calcium carbonate. These were discounted as most likely relating to the shelly matrix in which they were found. A total of 54 spectra on 25 tools was found to be mineral (see Illustration 440, left). Background checks were done on local soils and from this 12 spectra were interpreted as characteristic of standard ore soils and thus eliminated. Six tools contained only spectra representing ore soils, so that the total number of tools containing useful mineral data was reduced to 19.

Magnification 1031×

The overall results for the mineral spectra on these 19 tools can be found in Table 128, and the minerals are described below.

Table 128	
Tool	Residue
An Corran 18 (2 spectra)	rutile or ilmenite
An Coran 21 (2 spectra)	rutile or ilmenite
An Corran 28 (1 spectrum)	rutile or ilmenite
An Corran 57 (4 spectra)	rutile or ilmenite
An Corran 7 (1 spectrum)	copper carbonate
An Corran 7 (4 spectra)	chromite
An Corran 7 (1 spectrum)	zinc carbonate
McArthur's Cave 169 (3 spectra)	mercury ore and silver ore ?
McArthur's Cave 80 (1 spectrum)	zinc carbonate
Morton 434 (3 spectra)	rutile or ilmenite and zircon
Oronsay 279 (1 spectrum)	tin oxide
Oronsay 279 (1 spectrum)	barium sulphate
Oronsay 283 (1 spectrum)	barium sulphate
Oronsay 283 (1 spectrum)	tin oxide
Oronsay 335 (1 spectrum)	tin oxide
Oronsay 356 (1 spectrum)	monazite
Sand BT13 (4 spectra)	iron /manganese oxyhydroxide
Sand BT14 (2 spectra)	iron oxyhydroxide
Sand BT3 (4 spectra)	lead and tin oxide
Sand BT6 (2 spectra)	lead and tin oxide
Sand BT2 (1 spectrum)	manganese oxyhydroxide
Loch a Sguirr (SFS 8) BT41 (1 spectrum)	bismuth

Table 128: Mineral spectra on bone tools

Monazite (Oronsay 356) is a cerium and thorium phosphate which is common in granitic rocks. Today the thorium found in monazite is extracted and used to create a colour for ceramics.

Zircon (Morton 434) is zirconium silicate and is a common soil mineral. It is also used today to produce a pigment known as zirconium yellow. Zirconium salts are used today as tanning agents.
Rutile (TiO_2) and ilmenite ($FeTiO_3$) are titanium oxides (An Corran 18, 21, 28, 57, Morton 434). They can both be found in soils but also produce a white pigment when crushed into powder. Indeed rutile titanium oxide is described as producing "a richness of colour unmatched by any other pigment available today" (source: www.uic.com.au/nip25.htm).
Chromite (An Corran 7) The report of chromium suggests the presence of chromite ($FeCrO_4$), which is common in basic igneous rocks in the west of Scotland. All compounds of chromium are coloured (except $Cr(CO)_6$); Dichromates are used today in tanning leather. Chromium compounds are used in the textile industry today as mordants and tanning agents. Halides and oxides of chromium can produce a range of colours, including red, green, black, white and brown.

(www.chem.uwimona.edu.jm:1104/courses/chromium.html).
Copper carbonate (An Corran 7). Copper is a source of both blue and green pigment. The presence of copper residue has also been noted on a flint tool in association with some copper rich pebbles from the Mesolithic site of Howick in No rthumberland (Hardy *et al* forthcoming b).

Zinc carbonate (McArthur's Cave 80). Zinc is a source of white pigment.

Barium sulphate (Oronsay 279, Oronsay 283) Barium sulphate is used today in powder form as a pigment and produces white.

Tin Oxide (Oronsay 279, 283, 335, Sand 3, & 6). There is evidence that tin has been collected in Cornwall since the early Bronze Age. Tin was found in streams and riverbeds, as gravel or pebbles. The tinners would prospect, rather like gold panners, working on the open moorland and using the natural flow of water to wash away impurities, leaving the heavier tin to settle out in specially constructed pits (www.chycor.co.uk/tourism/tolgus/page2.htm). Today, tin oxide (Stannic Oxide SnO_2) is used in ceramic colours and produces a black pigment.

Bismuth. (Loch a Sguirr 41) Bismuth is used today to produce a yellow pigment.

Lead and tin oxide (Sand 3 and Sand 6). The presence of lead and tin together may indicate a solder or other soft metal (like pewter).

Iron and manganese oxide (Sand 2, Sand 13, Sand 14). Ochre and haematite are iron ores that have been used since the Palaeolithic to produce pigment. There is a lot of evidence for the prehistoric use of ochre and haematite in many parts of the world, for example in the Upper Palaeolithic Cave paintings and even earlier (Wadley *et al* 2004). Iron oxides are particularly useful for pigment as they do not fade with time in the way that pigments from animal and vegetable sources do. Ochre is particularly useful for tanning hide due to its antibacterial properties that protect and preserve. Lumps of both ochre and haematite have been found at Sand.

Sources of minerals

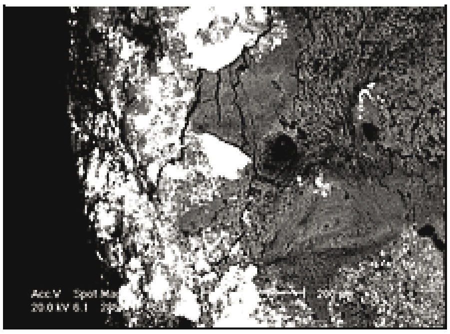
All the minerals described above, with the exception of tin and bismuth, are common in Scotland. Tin does occur, but rarely, and in specific locations in the north Highlands and the southern Uplands. The presence of bismuth is unusual as it is not common in Scotland. It occurs in small quantities near Dalbeattie in Kirkcudbrightshire, but it is more commonly associated with tin sources in Cornwall.

3.4.5.4 Discussion of use-wear examination

Bevel ended bone tools and pigment

The results of the study of mineral residues on the archaeological bone tools are intriguing. Every residue that was found, with the exception of the lead and tin, is used today to produce pigment or as a mordant or dye fixer. The precise mechanisms by which the minerals attach to the bevelled ends of the bone tools need further study, particularly given the loose, soil free, shell middens within which they were all found. Further background work, including for example analyses of rain water and local histories of sedimentation together with comparative sampling of non-artefactual bone, is clearly important. For the moment, the mere presence of the residues is a first, and a clear pointer to the value of more detailed analysis.

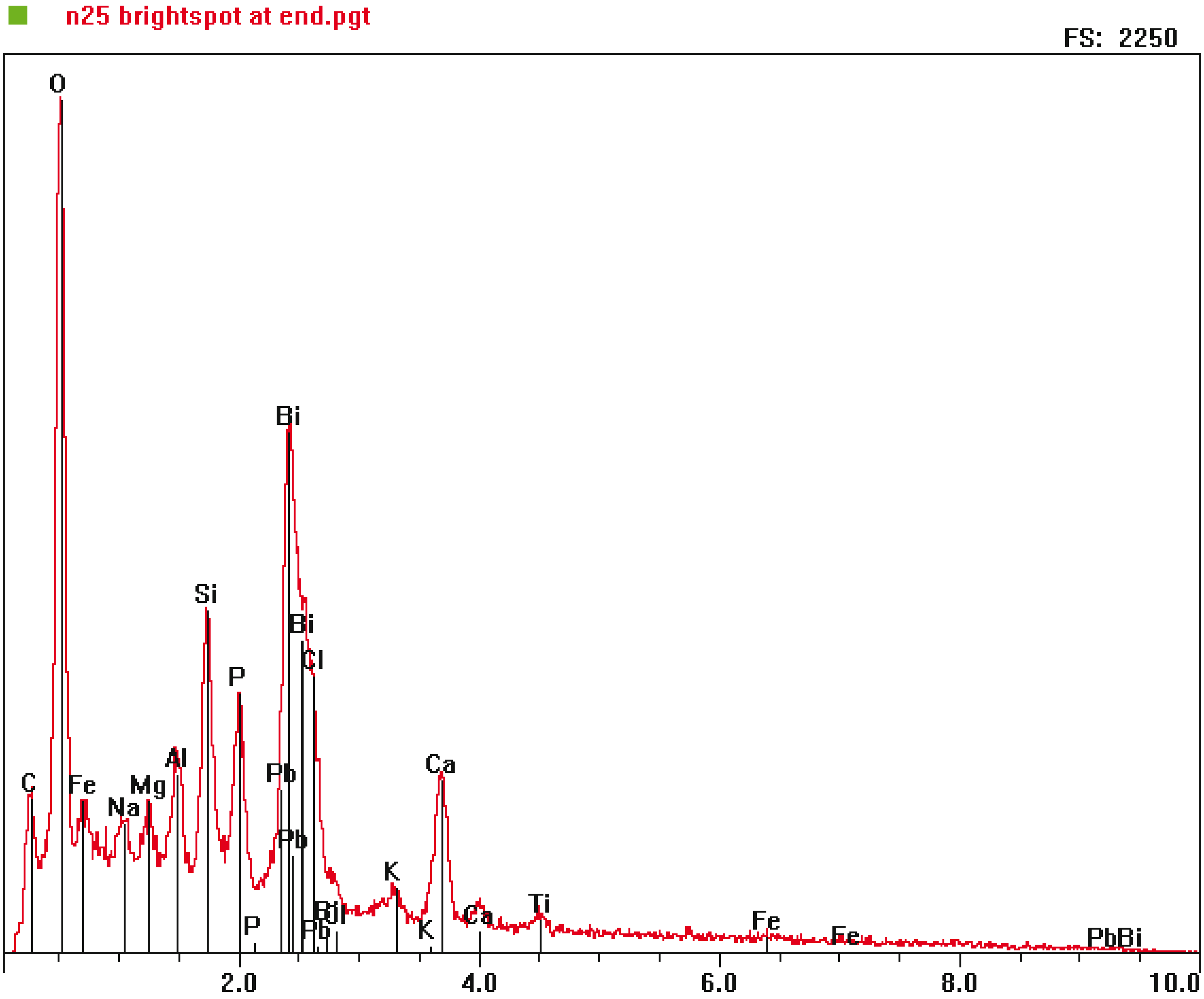
The presence of a lead and tin oxide suggesting solder at Sand may be contamination (see Illustration 441, right). Modern contamination can be ruled out; the bone tools were carefully treated and tracked since excavation. There is, however, evidence of an event of prehistoric metal working at Sand on top of the shell midden. Both of the tools with the lead and tin oxides (Sand 3 and Sand 6) come from the same area (B25A NE) but at different depths. The evidence for metal working occurs at a different part of the site, but it is conceivable that a drop of solder might have worked its way through the midden to contaminate these tools.



Illus 441: Sand BT35. Lead and tin mineral residue

Tin also occurs on three tools from Oronsay. These tools were excavated in the 19th century and the lack of a post-excavation history of the tools means that it is not possible to rule out modern contamination.

The presence of bismuth on one tool from Loch a Sguirr is intriguing as it is a mineral that is rare in Scotland (see Illustration 442, below). This tool has been tracked since excavation, and modern contamination can be ruled out.



Illus 442: Loch a Sguirr – BT1, Bismuth spectrum

Taken together the results suggest the exploitation of minerals during the Mesolithic, and one of the most likely explanations is that they served as pigments. The presence of colour has only recently begun to be accepted for prehistoric Scotland, let alone the Mesolithic. Ochre and haematite have recently been documented from Neolithic sites (Isbister 2000), and they occurred at Sand (Section 3.7). Other sources of colour may well have included dogwhelk which was plentiful at Sand (Section 3.12). Possible dye extraction from dogwhelks (they yield a purple dye) has been recorded from Smoo Cave

(Ceron Carrasco 2005) as well as in Mesolithic Ireland (Jackson 1917; Gibbons & Gibbons 2004). Copper too may have been used for its properties of colour. The use of copper as a pigment has been recorded in prehistoric America (Vermilion *et al* 2003) and the presence of a tool with copper residue at An Corran is interesting. Copper has also been recorded on a flint tool at the Mesolithic site of Howick, in No rthumberland on the east coast of England, in association with some lumps of coarse grained sedimentary rock with visible copper (Hardy *et al* forthcoming b). This suggests that the colouring qualities of copper may have been known and used from an early date.

Bevel ended tools as hide processors

The experimental work in processing hides with bevel ended bone tools (Birch above, Section 3.3.4) produced highly polished bevels and microscopic traces (longitudinal scratch marks) that correspond well to those on the archaeological tools. Although at first glance the archaeological tools might be thought small for this, the experimental replicas were very effective.

Many different processes of hide working have been described around the world, but each involves a series of well defined stages which employ different tools. A modern ethnographic account of goat hide working in Morocco can be found in Ibanez *et al* (2002).

Ibanez reports that the dead animal is left for a short time to swell so that the skin stretches and separates from the subcutaneous fat. The skin is then cut at the rear feet and pulled off from the back to the front of the animal. The skin is submerged in water for two to four days and then beaten against a stone to soften it. The skin is then submerged in a bath of water and quicklime for 10–15 days.

Illus 443: Hide tanning in Morocco (from Ibanez *et al* 2002)

The next stage consists of de-hairing and cleaning off the quicklime for which a flat stone is used to scrape both sides of the hide. Tanning is then carried out. Hides are composed of collagen in a fibrous structure and the aim of tanning is to form irreversible chemical cross links to the collagen matrix to prevent degradation by thermal, chemical or biological action. For this, the application of a tanning agent is necessary: in Morocco, one traditional tanning agent is green oak bark. The tool used to cover the skin with the tanning agent is small and the work is done carefully (see Illustration 443, right). Other traditional tanning agents include ochre and urine. Common modern tanning agents include rutile, chromium and zirconium. Following tanning, the hide is dried and washed in clear water and hung to dry. Finally, the skin is softened, by lightly wetting in water, (the water is blown onto the skin from the worker's mouth). The skin is folded and pressed for several hours, after which it is beaten with a stick, then pulled and stretched. Finally, the skin is placed on a wooden pole and scraped with a rounded pebble until soft.

A different account of hide tanning in northern Canada is described in the ethnographic work of Beyries (1999). Large bevelled and indented bone tools are used to deflesh and remove fat from the inner side of dry hides while they are stretched over a frame. Wet hides are processed differently using large concave tools, though Beyries found that only semi sedentary or sedentary people used this method (*ibid*, 1999). During dry hide processing two different convex tools of bone were used; one with a wide working edge (>350mm) and one with a narrow working edge (<30mm). The narrow tools (most similar in size and shape to the bevel ended tools of Mesolithic Scotland) are used to scrape dry hides of medium sized animals such as deer once they have been stretched over a frame. Beyries' explanation of the working method perhaps gives an insight into the non-symmetrical nature of the bevels on the archaeological bevel ended tools.

> "When a tool strikes the hide, it turns on its axis, and the stroke is not made

> by the middle of the working edge… but to one side, depending on which hand applied the pressure: it lies to the left if the left hand is close to the edge, and to the right, if the right hand does. Consequently, the edge wear is always off-centred”
>
> (Beyries 1999:125).

This observation was supported by Birch in his experimental work (above).

It seems likely that at least some of the archaeological bone bevel ended tools were used to process hides. Both the experimental work (Birch 2003 and above Section 3.4.4), and the wide range of ethnographic evidence for the use of this type of tool in hide working, lend support to this. The presence of potential tanning agents as residues on many archaeological pieces may be significant. Mineral pigments have a long history of use in Europe, and the population of Mesolithic Scotland will have had a deep understanding of the natural world.

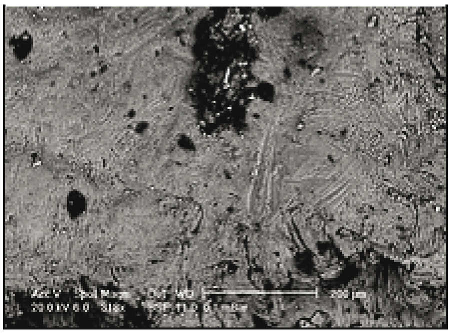
Bevel ended tools as limpet processors

The supposed use of limpet hammers involves two separate processes, the removal of limpets from the rocks, and the extraction of the meat from the shell (Griffitts & Bonsall 2001). Birch’s experimental programme looked at both with regard to bone and antler tools and discounted them. The use-wear on these experimental tools was examined with the SEM and compared to the archaeological samples. Interestingly, none of the traces on the experimental tools bore any comparison to those on the archaeological material. Use-wear traces from the tools that had been used on limpets were very irregular, comprising deep groove-like traces, while the archaeological samples mostly had a smooth finish on their bevelled surfaces. Equally, the bevelled shape created by the experimental work did not correspond to that found on the archaeological samples. Contrary to previous suggestions (Griffitts & Bonsall 2001), bone bevel ended tools are unlikely to have been used to process limpets. This may partly be due to procedural problems with earlier experiments, some of which sought to avoid the unnecessary killing of limpets (Birch’s limpets were used for bait).

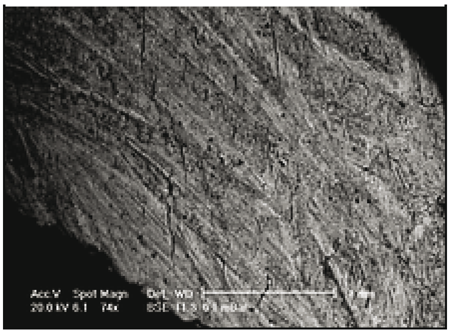
It is worth noting, however, that Birch did find pebble tools an effective means to harvest limpets from the rocks, particularly when they were still under water, and his pebble quickly began to develop a bevelled end similar to those on archaeological stone bevel ended tools (supporting work by Roberts 1987 & Mithen 2000). In addition, work at Sand in 2003 with children aged 6–11 showed that they were able to collect limpets easily in the ebbing tide, either by hand or with a small beach pebble. This perhaps adds weight to the argument that bone bevel ended tools are not a straight analogy for stone versions.

Use-wear traces

Several archaeological tools and some experimental tools were examined for use-wear under the scanning electron microscope. A comparison of the traces from the experimental tools used on limpets (see Illustration 444) and sorrel leaves (see Illustration 445) does not appear similar to the traces found on the archaeological tools examined (see Illustrations 446 & 447).

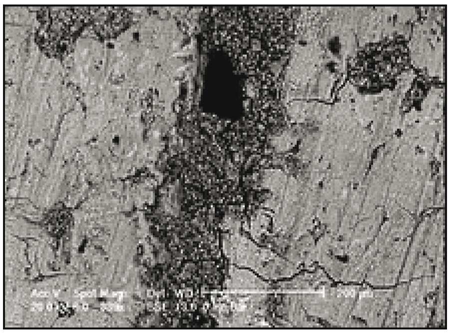


Illus 444: Experimental Tool 1. Used on limpets. 318× magnifications



Illus 445: Experimental Tool 7. Used on sorrel. 74× magnifications

Illus 446: Tool from Macarthur's cave, 923× magnifications



Illus 447: SFS 4, Sand: BT8, 339× magnifications

3.4.6 General Discussion

The assemblage of bone tools from Sand is similar to that from other Mesolithic shell midden sites in Western Scotland. Bevel ended tools are the most common bone tool type on many sites, both with points and without, and simple pointed tools are also found at many sites (Saville 2004c). Barbed points (harpoons) are less common in general and the one small fragment found at Sand is therefore significant, though sadly not enough has survived to draw any stylistic interpretations from it. No evidence for the working of antler was found, though the presence of four pieces of antler with cut marks does suggest that it was used. It seems that tools of antler may well have been used away from known archaeological sites as it is not uncommon for general evidence relating to antler working to be found in middens rather than the tools themselves (Saville 2004c). The only common Mesolithic tool type not to appear on site is the antler mattock, and this is interesting because fragments do appear on many other midden sites (Saville 2004c).

It is worth considering the bevel ended tools in more detail because of the previous debates over this tool type. Bevel ended tools have been found in all Mesolithic shell middens in Scotland (and beyond) and the examples from Sand fall well within their known age range. Because of their association with shell middens they were linked from early on to limpet working, and this is a view that it has been hard to shift, perhaps because of a general lack of familiarity with both bone tools and limpet processing. However, the archaeological distribution of bevel ended bone and antler tools is unlikely to be a true representation of their distribution in prehistory. Their presence in shell middens is linked to the precise conditions and protective environment of the shell midden; they would not survive elsewhere. At Sand this is highlighted by the level of degradation noted in the bone at the limits of the midden, both for artefacts and ecofacts. No bone tools were found beyond squares B4 or A3 which represent the extreme north and east limits of the shell midden respectively (see Table 129, below).

Table 129

Sand – State of bone	Good	Medium	Poor

In shell midden	18	19	3
Squares B4 and A3 at the limit of midden	1	8	2
Totals	19	27	5

Table 129: the condition of the bone tools at Sand

Though further work is required, it now seems likely that bevel ended bone tools such as those from Sand, and many other Mesolithic sites in Scotland, were not used for the processing of limpets. Using a range of data including ethnographic, morphological, use-wear analysis and experimental work, there is strong evidence to suggest that they are much more likely to be related to hide working. This adds support to some previous research on the subject (Foxon 1991; Finlayson 1995). It would also not be out of step with the possible wider presence of the tools than that indicated by the shell middens alone.

While the study of bone and antler bevel ended tools may be changing direction it is also worth noting that the evidence here suggests that previous assumptions that stone bevel ended tools served similar functions (for example: Saville 2004c) should also be questioned. This is borne out by Clarke's work on the coarse stone tools from Sand and elsewhere (Section 3.6).

Other uses of bone may not yet be recognised in Mesolithic Scotland. A number of small bone flakes with percussion bulbs were identified and this suggests that bone working was being carried out on site. A quick scan of the material culture from Mesolithic sites with better preservation elsewhere in Europe reveals a range of finely worked bone artefacts including arrowheads, knives and points (Oshibkina 1985; Zagorska & Zagorski 1985). Given the traditional emphasis of hunting and archery in our interpretations of the Mesolithic one obvious bone artefact type that is missing is the arrowhead. These might comprise not only the well documented broad tipped wild-fowling arrowheads (*ibid*), but also sharp slivers of bone for which there is considerable ethnographic documentation (Lee & Devore 1976; Hardy & Sillitoe 2003). Sharp bone arrowheads have the advantage over stone in that they can induce septicaemia. For this reason they were considered particularly efficient and deadly among the Wola of Papua New Guinea (Hardy & Sillitoe 2003). Arrowheads, of course, are less likely to occur on site, but it is interesting that they are found elsewhere in Europe, and the bone assemblage from Sand contains many slivers of bone that could have served this purpose. Bone tools were certainly an important part of the material culture at Sand and it is possible that there are elements of the bone tool assemblage that still lie unrecognised.

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… > Images > Artefacts > Worked Bone > SFS_BT12.jpg [Illustration 398]
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