APPENDIX 3 Butchery Experiment

A3.1 INTRODUCTION

The overall aims of the experiment were to provide a fuller understanding of butchery methods to aid interpretation of butchery marks on bone, and to compare the use of flint and iron tools in boar butchery. This interpretation could then potentially shed some light on the status of butchers/ butchery at Danebury, since iron has been regarded as having a higher status than flint in this period (Young and Humphrey, 1999). The validity of the author's interpretation of marks on the Danebury material which underpins this thesis could also be tested. The objectives of the experiment fell into five main areas, outlined below.

The first objective was to assess the relative merits of three hardnesses of iron knives and several types of flint tool (scrapers, blades) when performing different tasks including disarticulation and filleting of meat from the bone. Butchery marks on pig bone suggest that these tasks were performed at Danebury, although it is not certain which tools were used for these tasks. Both iron knives and flints[1] have been found in Iron Age contexts from Danebury, and recently Young and Humphrey (1999) have suggested that flint may have been used in Iron Age domestic tasks. Butchery could be just such a task, and one for which the use of 'expensive' iron objects was not suitable. Comparisons between the replica tools and modern steel knives did not form a prime objective although differences have implications for the speed and accuracy of the butcher's work. Saws were found at Danebury, but saw marks for butchery were not identified on the domestic animal bone.

The second objective was to gain important empirical insights from a skilled professional butcher in order to verify the author's interpretations of Iron Age butchery, including the proposed order of dismemberment and the coincidence of cutmarks on the modern carcass and those observed on the bones from Danebury.

[1] No Iron Age flints were illustrated in the site report, but flint pieces in the forms identified by Young and Humphrey (1999) are present in the archive. Humphrey's preliminary analysis identified pieces deemed typical of Iron Age flint; these were used as prototypes for the experimental flints and two are described below:
a). DA72, P291/2, Find No. 890: Fresh broken flake- bifacially worked on one edge for cutting knife. Cortex on opposite side.
b). DA85, P2424/1, Bulk Find: Fresh very large flake from core, bifacially worked on distal edge to form cutting. Chopping edge. Tool.

The third objective was to record matters of importance to the study of meat consumption in the past, including correlations between live, dead, dressed and bone weight. These are secondary to the main emphasis of the experiment, but nonetheless have the potential to show differences between the efficiency of the two tool materials.

The fourth objective was to identify use wear on each of the knives and flint, including detailed microscopic analysis. The number of sharpenings and weight loss during use was recorded, together with which tasks the tools were used for and how many times. Again this is peripheral to the main focus of the study and of limited relevance, but may help when considering the appropriateness of different materials for butchery.

The final objective was to investigate the morphology of cuts into the bone, in order to compare these to the butchery marks at Danebury, in an attempt to identify which tools may have been in use for butchery tasks in the Iron Age.

A3.2 BACKGROUND[2]

The original intention of the butchery experiment was to disarticulate and fillet an entire boar with iron and flint cutting tools, in a similar manner to the butchery process interpreted from the Danebury assemblage, and to see if and how the marks on the carcass corresponded to those in the archaeological record. Iron knives had been found at Danebury, and a colleague (Jodie Humphrey) was investigating the potential for the use of flint in domestic contexts in the Iron Age.

A boar was chosen as its bones and musculature were thought to more accurately represent the ‘unimproved’ pig of the prehistoric period which contained less fat than modern examples, and was heavily bristled (Lawrie 1998; Malcolmson & Mastoris 1998). The boar was from a free range farm in Cornwall, and it was thought that the exercise that free range animals enjoyed would produce individuals of more similar musculature to those in the Iron Age than those kept in confined spaces on pig farms. It was expected that the bone density of a boar might be higher than that of modern breeds which are bred to mature fast for a quick turnover of meat. Denser bone was expected to be more resistant to marking with cutting tools.

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[2] The idea for the experiment came about during a seminar discussion between the author, Jodie Humphrey, Dr Rob Young and Dr Annie Grant.

Knives were made for the experiment by Peter Crew, the archaeology officer of the Snowdonia National Park Study Centre, in conjunction with a blacksmith, Hector Cole, using iron smelted with what are thought to be Iron Age techniques (see Crew 1991). The forms of the knives were based on those recovered from Danebury, and the most suitable for butchery were chosen in consultation with the butcher. Three knives were made of differing carbon and phosphorous content, shape and size (see figures A3.1 and A3.2).

These may have been smaller than those at Danebury if the Iron Age knives had been sharpened many times prior to deposition and their edge worn away. Flint scrapers, flakes and knives in various sizes (see figure A3.3), were produced by Linden Cooper, project officer at the University of Leicester Archaeological Services and Jodie Humphrey, based on her analysis of flints thought to be of Iron Age date from Danebury (figure A3.4).

The experiment was organised for September 2000, and Mr Wood, a traditional butcher, had kindly made himself available for a full Sunday to perform the butchery, in accordance with the methods hypothesised from the author's interpretation of the butchery marks. The week before the experiment saw the instigation of major fuel protests across the UK, with hauliers, farmers and taxi drivers blockading major depots. As fuel supplies slowly ran out across the country, a crisis developed for emergency services, and the farmer who was to have supplied our boar was unable to do so.

The experiment was rescheduled for November 2000. However the butcher developed glandular fever and was unable to work at all, and the experiment was again rescheduled, this time for March-April 2001 when the butcher was feeling well enough to do work additional to his main employment. The outbreak of foot and mouth in Britain was first recognised in early February 2001. The farmer who was to provide the boar had his animals condemned on Tuesday 27th March, four days before the experiment was due to take place.

Time constraints did not allow for another rescheduling of the experiment, and instead a smaller scale one was undertaken. The butcher simply kept two heads and hocks of pigs he received for butchery and resale, and each of these was subject to disarticulation (of the jaw) and filleting of the meat from hocks, mandible and skull. Trotters had been removed from the carcasses to reduce risk of foot and mouth contamination, so these were not available for investigation. The carcasses were those of two females aged between 6 and 8 months[3].

The modified experiment limited the potential for testing assumptions about butchery in the Iron Age, especially since the bone was from modern breeds and likely to be easily marked. The meat very probably had a higher fat content than Iron Age meat, and the skin almost certainly softer to cut through, which could affect the cutting edge of the blades. However the experiment still had the potential to address questions concerning the impact of tools upon bone, the potential for the use of flint in butchery as an alternative to iron knives, and the correlation of the positions of butchery marks with particular activities.

A3.3 METHODOLOGY

The butcher was asked to skin, disarticulate and fillet the bones if possible, and to split the skull and mandible longitudinally. The meat weights from each bone were recorded as they were removed, and retained for further investigation. Following completion of the experiment the bones were boiled for roughly an hour and the majority of the soft tissue picked off. Knives were not used as this could have created further marks. The bones were then soaked in a solution of pepsin at 35 degrees Celsius, in order to break down the remaining soft tissue adhering to the bone. The bones were left for 5 days, then boiled and scrubbed. The process was repeated as not much of the tissue was dislodged on the first attempt. The bones were then bleached by Tony Gouldwell, left to dry and the positions of cuts noted, measured and photographed (figure A3.5).

Cutmarks were examined by eye to identify if different types can be distinguished in non-microscopic identification of animal bone, and then examined under a microscope at x30 magnification.

[3] Grant's 1982 system of aging was used to calculate a mandible wear stage for the two animals. Differences in the relationship between age and tooth wear are expected since modern animals were probably fed very differently to the Iron Age animals, possibly on softer, less abrasive items. The improvement of breeds in the 17-18th centuries led to faster growing animals, which may result in modern individuals having earlier tooth eruption times than their Iron Age counterparts (Wiseman 1986).

Pig and side	M1	score	M2	score	M3	score	MWS
Pig 1, right	c	8	C	1	N	0	9
Pig 1, left	c	8	C	1	N	0	9
Pig 2, right	b	7	C	1	N	0	8
Pig 2, left	b	7	C	1	N	0	8

Table A3.1: Mandibular Wear Stages of the two pigs used in the butchery experiment.
On both animals the first molars were in wear but the second had not yet erupted. Silver (1969) gives an age of 4-6 months for the eruption of the first molar in modern animals, and of 7-13 months for the second molar. The butcher's age of 6-8 months is consistent with Silver's figures for modern animals.

Some butchery had been undertaken prior to the experiment during disarticulation from the main carcass. Using stainless steel blades, the butcher had separated the hocks from the upper leg at the proximal radius and ulna, and sharp knife cuts were visible on the cleaned bone. The separation of the skull from the rest of the carcass created similar cuts on the occipital condyles. Circular saws had been used in the abattoir to remove the feet and also to split the entire carcass in half lengthways cutting straight through the midshaft of the radius and ulna, and into the back of the skull, where the bone is thickest. The latter did not cut along the suture of the skull but was off centre, so the cuts made by the experimental tools did not run along the middle of the skull. This probably made the process of splitting the skull using the experimental tools more difficult and as a result the morphology of the cuts created may have been affected.

A3.4 RESULTS

A3.4.1 Comparison of knife and flint

Process: Filleting out the meat from the upper radius/ ulna.

The flint knives were good at cutting through skin and flesh, and the butcher found it easy to remove most meat from the bone. Skinning was also undertaken, but the result was uneven and he attributed this to his lack of practice with the tool rather than the tool itself. The functioning of the iron knives varied according to their softness, but the butcher said that they were much easier to use than the flint, partly because he was used to them and partly because they were easier to guide. The softest was not sharp enough to cut easily through the skin.

Process: the skull was split longitudinally, the mandible was disarticulated from the skull, and the meat on the sides of the jaw and head and the tongue removed.

The flint was used as a wedge, with a hammerstone to split the skull. This was achieved with some force and chips of flint shattered some distance. The iron knife was also hit with the hammerstone; this tool was more easy to direct (figure A3.6). The tongue was removed and the mandible split easily with both types of tool. The mandible was then removed from the skull, using a sawing action with many cuts to the medial condyle area (figure A3.7). Physical force was used to separate the jaw and skull, which resulted in parts of the mandible snapping off. The rest of the meat was then removed from the bone.

A3.4.2 Comparison of the experimental cuts and those observed at Danebury

a). Position of cuts

Physical evidence of the butchery using flint tools showed only along the length of the skull (figure A3.8), where it had been split, and on the mandible. Cuts to the mandible were found on the lateral and medial side across the angle (figure A3.9), where the meat was filleted out, and into the articulation on the posterior edge, from disarticulation. Both sides had suffered loss of the coronoid process where the bone had been snapped off during disarticulation. The splitting of the mandible and the skull did not follow the suture, but was asymmetric, falling to one side and leaving the fore part of the mandible almost intact.

The marks made with flint tools therefore reflect some of the marks seen on bone from Danebury, especially those interpreted as resulting from the filleting of meat from the mandible, and the separation of the mandible. However marks resulting from the splitting of the skull and mandible are not mirrored at Danebury: it is likely that at Danebury the mandible was not broken during disarticulation, but that more cuts would have been made to the upper parts to remove the lower jaw.

Cuts to the skull made with iron knives were visible under the orbit and along the frontal bone, as well as on the mandible (figure A3.11). Those used to split the skull were also visible (figure A3.10). This may imply that knives leave more traces of cuts on the bone, although it is possible that the butcher simply used this tool with more force as it was more familiar to him.

Cuts to the mandible were found beneath the toothrow on the lateral side, and these were created during filleting. Many disarticulation marks were found on the medial side, cutting up and into the condyle, with some cutting across the medial and into the anterior part of the angle. Again parts of the mandible had been completely broken off: the entire articulation had been snapped from one side. Cuts to split the skull and mandible laterally were again off-centre, as the butcher followed the mechanically made cut.

Filleting cuts were found on the skull below the orbit (in exactly the same position as those at Danebury). One cut along the frontal part looked as if it had been made by ‘shaving’ off the flesh, and occurred during removal of the skin from the skull. The marks that resulted from skinning the experimental skull did not occur at Danebury. Skinning of the animal would normally have occurred before disarticulation, to remove large parts of skin, so it cannot be expected to produce similar marks when performed after disarticulation.

Cuts made with knives are consistent with some of the activities hypothesised for Danebury. Cuts to remove meat below the toothrow were not found on pig bones at Danebury but were found on cattle bones. Cuts below the orbit were mirrored on the Danebury pigs. The cuts across the medial side of the angle are similar to cattle bone butchery marks from Danebury. The heavy cuts into the articulation for disarticulation are not mirrored at Danebury and this could be due to the bluntness of the knife, or excessive force used in disarticulation in the experimental procedure.

The most important differences result from the splitting of the skull and the disarticulation of the mandible. It is likely that at Danebury the mandible was disarticulated using dextrous cuts into the articulation, evidenced by cuts to the condyle of the mandible and beneath the orbit. Since the majority of the Danebury pigs were generally older and of a different conformation to modern animals, it is less likely that the mandible could easily be snapped off, especially as the bone from unimproved species is denser. The cuts to split the skull did not follow the suture, and this may be misleading, but it is not likely that a hammerstone was used to split the skull, due to cut morphology (see below).

b). Frequency of cuts

Cuts made with flint and iron tools were observed on the head, but only one was found on the radius (apart from those created from the initial disarticulation of the hocks from the trotters and humerus) from an iron knife. All parts were stripped of meat, and it is notable that these lower limb parts were mainly unmarked even though the process was performed by a person unfamiliar with the tools. This could suggest that the majority of cuts made did not mark the bone and may explain why only 2% of the Danebury pig bones have cutmarks on them. While it is possible that these 2% may be unrepresentative of the general methods of butchery, it is perhaps more likely that they were made by inexperienced or careless butchers and are in fact representative of the techniques used in the Iron Age.

The experimental procedure left many flint and iron knife cuts on the skulls. Rather than suggesting a contrast between the experimental and Iron Age butchery methods, it is possible that the relative bluntness of the iron knives, and unfamiliarity of the tools caused the butcher to have less control over the cuts he made, causing deeper and more frequent cuts to the experimental skulls. Stanford and colleagues have suggested that flint cuts easily through flesh but does not readily sever the myelin sheaths around muscles (Stanford *et al* 1981). This does not accord with the comment that Mr Woods made about the proficiency of flint tools at cutting through both skin and flesh, although it is possible that no unbroken myelin sheaths were encountered in this experiment.

c). Nature of cuts

The cuts made to split the skull using flint tools were extensive: such cuts have not been found on the Danebury material. On the top of the skull the blows with the hammerstone had caused the bone to come off in discs, leaving scooped out fractures (figure A3.8). The use if iron knives resulted in similar fracturing of the bone but on a much smaller scale, and the cuts were more even. The flints had caused an uneven scooped cut, while iron tools had left something more recognised in the Danebury material, a slightly ridged appearance (figure A3.12). These ridges were in evidence in cuts to split the skull, remove the eye and where bone had been scraped off the frontal part.

Flint cuts for disarticulation of the jaw were deep and v-shaped, those made with iron knives were v-shaped (●) and blunted v-shapes (●◙). The latter probably reflects the relative softness of the iron knives, which were not highly sharpened, although adequate for the butchery tasks performed. Such a cut in the Danebury material would have been interpreted as a ‘chop’. In fact the modern cut was made by using the knife in a sawing motion, and resulted in very deep cuts (up to 5mm).

Cuts for filleting using flints were v-shaped, although one was very faint. More of the iron knife cuts were blunted v-shaped cuts and one cut was more of a right-angled scoop.

Walker and Long (1977) performed an experiment using different tools to create butchery marks; the profile of the marks from their work corresponds with those produced in this experiment. The more blunted ●◙-shaped cuts are distinctive of knife cuts while sharp ●-shaped cuts are typically made by flint tools (Walker & Long, 1977: 609). The boundaries between the two types may be blurred depending on the force, angle and motion (sawing, chopping etc) of the cut. The cuts made by Walker and Long were shallower, probably a result of a coarser cutting edge which was produced by bifacial flaking. Since the pattern which appears in Walker and Long’s work is also that presented here, the relative bluntness of the iron tools compared to steel in this experiment may not have biased the results.

It is difficult to make unequivocal suggestions about tool use at Danebury: the iron knife cuts appear to mirror the splitting and scraping cuts from Danebury, and the flint cuts the disarticulation and filleting marks. It is of course possible that both were used perhaps at different stages of the butchery, or that the iron knife marks made in this experiment were made by unrepresentatively blunt tools.

A3.4.3 Meat and bone weights from the head and hock

The meat and bone from each individual was weighed to compare the ratio of meat to bone weight.

FLINT TOOLS	**Bone weight before cleaning (g)**	**Meat weight (g)**	**% Meat**	**Dry bone weight (g)**	**Dry bone as % of uncleaned bone**	**Dry bone as % of recovered meat**
Radius and Ulna	205	455	**69**	70	**34**	15
Skull	2160	880	**29**	440	**20**	50
Mandible (inc tongue)	705	1385	**66**	230	**33**	17
Head (total)	2865	2265	**44**	670	**23**	30
IRON TOOLS	**Bone weight before cleaning (g)**	**Meat weight (g)**	**% Meat**	**Dry bone weight (g)**	**Dry bone as % of uncleaned bone**	**Dry bone as % of recovered meat**
Radius and Ulna	185	400	**68**	65	**35**	16
Skull	1700	745	**30**	330	**19**	44
Mandible (inc tongue)	435	1455	**77**	150	**34**	10
Head (total)	2135	2200	**51**	480	**22**	22

Table A3.2: Meat and bone weights from the butchery experiment, to 5 grams.

The pig butchered with iron knives appears to have had a greater percentage of meat removed from its mandible, although table A3.2 shows that there is very little difference in the percentages of meat removed from the hock and skull.

The initial impression was that there was slightly more meat left on the mandible when using flint. This could be related to the bluntness of the iron knives, although if this were the case one would expect the pattern to be similar for the other bones. An alternative explanation is that the shape of the mandible meant the smaller flints were more efficient at removing meat from awkward parts.

When the dry bone was weighed, it was noticeable that there is very little difference between the two pigs in the proportion of dry to uncleaned bone. This suggests that both tools had removed a similar amount of meat from the skull. When the dry bone was compared to the amount of meat removed, it is clear that the pig butchered with iron knives in fact carried less meat on its head, with a similar amount on its hock. This could have been due to differences in the position of the cut to remove the head, although it is more likely that the conformation of these pigs was slightly different, possibly due to the gap in their ages. The pig butchered with iron knives was younger by 2 months. There is no difference between the two pigs in the proportions of meat on the hock, although this part carries less meat so differences would be less pronounced.

This analysis suggests that it is unlikely that the iron knives were less efficient at filleting meat from the mandible than the flint.

A3.5 CONCLUSIONS

From the limited evidence available, it seems that in the Iron Age the skull was probably not split using flints; nor is the use of iron knives for this task definitely established. It is possible an iron cleaver may have performed the task at Danebury. However, the pig skulls in this experiment were not split along the suture as those from Danebury were; a far easier and neater task. Both materials performed filleting and disarticulation tasks well, and either may have been in use at Danebury. The cuts found from filleting activities coincide with marks on pig bones found at Danebury, and they are also often mirrored by the marks found on cattle at Danebury. Modern pigs are closer to the size of prehistoric cattle. The position of cuts for disarticulation sometimes correspond in both tool types, but those from Danebury are less deep, probably suggesting greater familiarity with the tool type in the past.

The morphology of the cuts at Danebury is more similar in profile to cuts made by flint than iron knives, but the sharpness of the iron knives may be a crucial factor. It could be concluded that blunt iron knives were not in use for butchery at Danebury, although sharp ones may have been. The knives used in this experiment were perfectly adequate for the butchery tasks that were required, and it seems unlikely that a butcher would sharpen tools unnecessarily unless butchery were regarded as a specialised, artisan craft, or one in which time was an important factor. It may be that at Danebury butchery was a specialised craft for which sharp knives were used. It was certainly a craft which was performed carefully, as is shown by the meticulous disarticulation of the mandible, rather than breaking it (although it may have been more difficult to snap this part off a boar).

Most crucial to this study is the observation that the frequency of cuts to the skull in the experiment was more common than has been observed for Danebury. This was perhaps because pig heads at the hillfort were not skinned, although the unfamiliarity of the experimental tools may also be an important factor. The lack of cuts to the hock of the experimental animals suggests that in the past butchery may not have resulted in bone being visibly marked, a phenomenon noted by several authors including Peck (1986) and Guilday et al (1962). This means that although only 2% of the Danebury pig bone was marked, we should not conclude that the remaining 98% had not been subject to the similar butchery processes. The absence of butchery marks should not therefore lead us to assume that the animals were, for example, roasted whole.

This limited experiment has not provided conclusive evidence for the tool types used at Danebury for butchery. The sharpness of the tools is a crucial factor and further experimentation using sharper knives may add additional insights. However, there is some evidence to suggest that different types of tools were used for the most appropriate tasks and were not necessarily used exclusively.