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Chapter 7

Swords of the Anglo-Saxon and Viking Periods in the British Museum: A Radiographic Study

Janet Lang and Barry Ager

1. Introduction

A radiographic study of swords of the Anglo-Saxon and Viking periods in the British Museum was undertaken at the request of the Department of Medieval and Later Antiquities in order to facilitate their study. The corroded state of the swords often makes it impossible to determine without radiography whether or not the blades are pattern-welded or have inlaid pattern-welded inscriptions. Both are well recognised forms of decoration for the swords of the period, inscriptions being introduced at about 800 AD. In all, 142 swords were radiographed in the British Museum Research Laboratory. A few swords were in such a fragile condition that they could not be handled safely, and these were omitted from the study. This paper presents the results obtained and is not intended to be an extensive scholarly study of the swords. It is hoped that the information made available here will contribute to further research and comparative studies.

2. Definition and Origins of Pattern-welding and Damascening

The term pattern-welding is used to describe a process of welding together twisted rods to build up patterned blanks from which swords, daggers and spear heads were made. It is characterised by the presence of patterns on the blade which were originally visible to the eye, although in corroded specimens a radiograph may be needed to reveal them. The process of damascening with which pattern-welding is often confused, produces decorative gradations by varying the carbon content throughout so that a pattern appears at the surface. The best known examples of the latter technique are found on oriental blades. Tylecote (1976, p. 66) has commented that it is possible that there is no real difference in principle between pattern-welding and damascening, but at the same time, he also said that pattern-welding differs from damascening in that the starting material is low carbon iron and the strips are more elaborately twisted, agreeing with the earlier work of Maryon (1960), who distinguished clearly between the two. In Maryon's definition of pattern-welding, the patterns were produced by welding together twisted strips or rods of low carbon steel or even wrought iron, often with very similar compositions; in damascening, fine patterns are produced in steel by variations in composition which respond differently to etching and wear. The carbon content is often very high, thus increasing the hardness of the

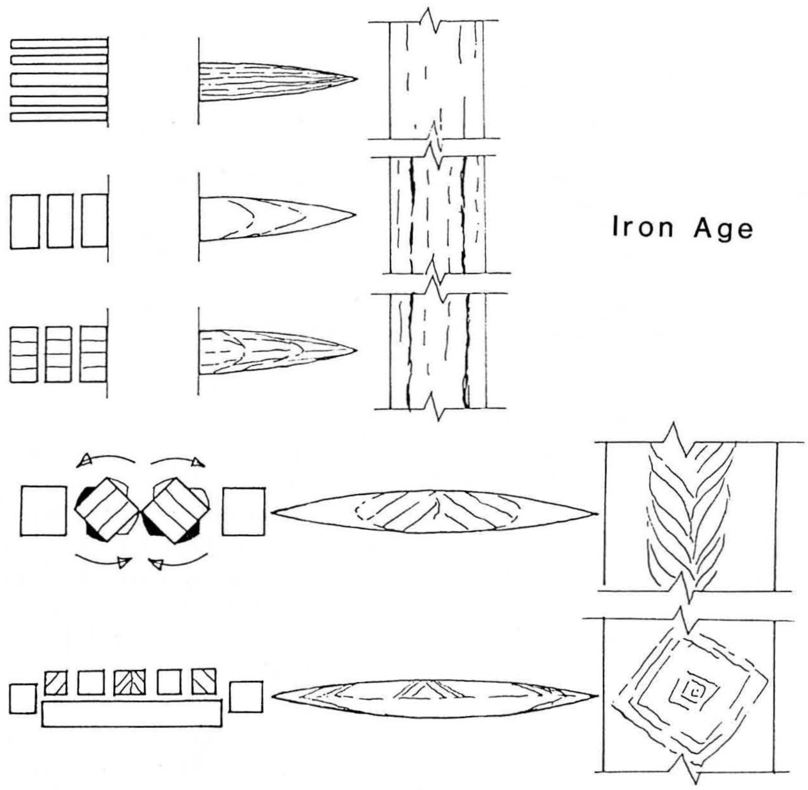

Fig. 7.1 Development of Pattern Welding

blade. These variations on damascened pieces may be (i) in the original piece of metal, for example wootz steel, which was produced in the East by a crucible process or (ii) introduced by welding together smaller carburised pieces or (iii) introduced by deliberately carburising at each stage as in the Japanese processes (Smith 1957) where a blade is made up by reworking and reforging the same piece of metal many times. Damascening has been discussed in detail by Belaiew (1918), Smith (1957, 1960), Wadsworth and Sherby (1979) and Yater (1983–84) amongst others.

The technique of pattern-welding, with which the present paper is mainly concerned, is known to have been used from the third century AD and appears to have evolved from the piled* structures made by the Celts and Romans (Lang 1984). These piled structures were constructed by forge-welding together a number of sheets or strips of iron laid on top of each other. The composite structure was then forged to the required shape. The components were frequently arranged with layers of carbon-rich iron alternating with layers of low carbon iron. A late British Iron Age sword from Waltham Abbey, for example, was forge-welded from at least 24 separate layers with different carbon contents (Lang 1984). The metal almost invariably contained slag, which had a strengthening effect if the inclusions were small and well dispersed throughout the structure; however if the slag inclusions were large, they had an embrittling effect. The use of a number of relatively

* piled or pile-forged, rather than whole blade beaten from a single bloom – avoids problem of large lumps of slag spoiling the blade and helps to carburise the iron better (J.L.)

small strips of metal for the blade probably helped to reduce the risk of large lumps of slag remaining. In the middle of the La Tène period another method of constructing composite blades was developed. In this, several long rods or strips of iron or carburised iron were placed side by side and welded together, so that the joins ran parallel to the edge of the blade, perpendicular to the flat surfaces, instead of in layers with the joins parallel to the flat surfaces, (from cutting edge to cutting edge) as they had in the earlier period (see Fig. 7.1). Then, during the late La Tène period, i.e. the first century BC to the first century AD, the smiths began to twist the strips before welding them together. A sword from Llyn Cerrig Bach, Anglesey (no later than the first century AD) showed evidence of twisting (McGrath 1973) and is believed to be one of the earliest examples of the use of deliberate twisting.

Later, sometime in the third century AD, the twisting became more complicated and true pattern-welding could be said to have started. In this process a complex structure was built up by plaiting or twisting iron strips (which were sometimes themselves made up from a number of strips) and then welding them together (Anstee & Biek 1961). The patterned piece was used to make the central sections of a sword blade, or part of a knife or spear head. Some of the earliest pattern-welded swords, from the third and fourth centuries AD, were found at Nydam in Schleswig Holstein (Schürmann 1959), the Rhine, South Shields (Rosenquist 1967) and at Canterbury (Webster 1982).

The first scientific study was made of the Nydam swords in 1927, by Neumann, and then the next was Maryon's examination of a Nydam-type sword from Ely in 1948 and this was followed by many papers, particularly on material from Eastern Europe, notable contributors being Pleiner (1969), Anteins (1966, 1968) Piaskowski (1961). Studies have also been made by France-Lanord (1949, 1952), Liestøl (1951), Salin (1957), Panseri (1963), Emmerling (1972, 1978, 1979), Menghin (1974, 1983), Ypey (1960, 1973, 1982, 1983), and Müller-Wille (1970, 1977, 1982), as well as Maryon (1948, 1950, 1960), Anstee and biek (1961) and Gilmour (in Tylecote 1986). Experimental pattern-welding by Anstee and Biek (1961) showed that patterns can be obtained even with strips of the same virtually carbon free iron. They also observed that the convolute patterns produced by sectioning a screw thread longitudinally near the axis were replaced by a curving herringbone structure when more of the surface was ground away. This feature makes grouping the swords by their patterns difficult. Neumann (1927) distinguished three types of pattern, streifendamast, winkeldamast, and rosendamast, which could be translated as "straight", "chevron" or "herringbone" and "curving", a system followed by Schürmann (1959). Emmerling (1972) also suggested three categories of patterns: V-forming, N-forming and M- or W-forming. Although these categories provide useful visual descriptions, in the present study it was decided that a simple but slightly more fundamental distinction could be made on the basis of the number of strips or strip composites making up the patterns. Some of the rods were twisted for their whole length while others had straight sections interspersed with twisted sections and these characteristics provided sub-divisions of the main categories. Anstee (1961) also recorded the number of strips used in each blade in his paper, describing the patterns as standard (continuously twisting) and alternating (alternating twisting and straight sections). Koch (1977) also used the number of strips as a type indicator. There are drawbacks to this method of categorising the patterns, which are inherent in the radiographic method. It is difficult to see if two layers of pattern are present, if they are superimposed, many patterns cannot be fully understood from radiographs and the number of strips making up each

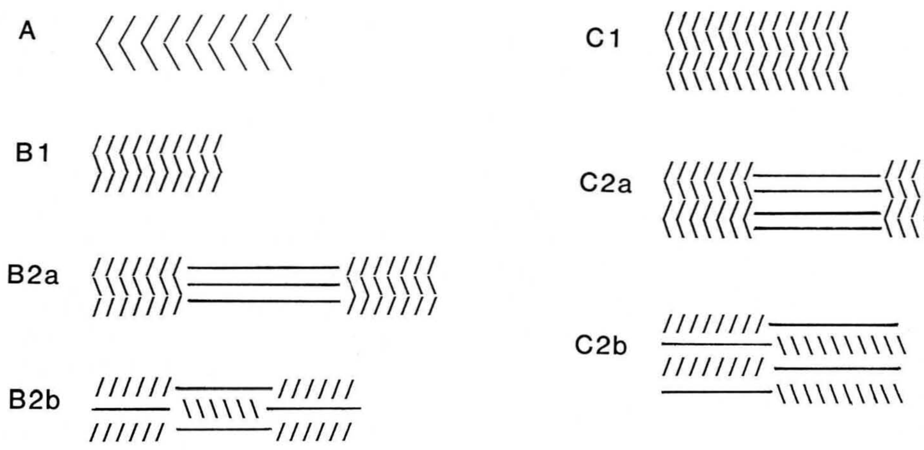

Fig. 7.2 Diagram of pattern types on welded swords.

band or element cannot be distinguished. Radiographs have other disadvantages: they do not show the presence of complex edges, which Gilmour (Tylecote 1986) found to be quite common, or cores, which also may consist of more than one layer. Schürmann (1959), for example, has described the metallographic examination of three of the Nydam swords. One of these was constructed from eleven pieces, all with different carbon contents. The edges and pattern-welded surfaces were welded onto a core which itself was made as a sandwich, with a medium carbon steel sheet between thin soft iron plates. The carbon content of the pattern-welded strips varied between 0.1 and 0.6%. After examining a number of Scandinavian swords metallographically, Liestøl (1951) suggested that slices cut from welded twisted composite bars were welded together with their sliced faces uppermost, to form surface sheets sandwiching a core of plain metal.

It was not possible in the present study to make metallographic cross sections which would have shown the number of layers immediately and also incidentally allow some assessment of the quality of the sword as a weapon, such as the hardness (and therefore sharpness) of the edges, for example. However, it has been found in this study that stereo radiography helps to identify swords which have two layers of pattern, a number of which have been found in the survey. (See 4, ii below)

3. Experimental

Radiography was carried out using a Raymax machine (nominal maximum 150 KV), with either Kodak Industrex 'C' or 'A' strip film. The film to source distance was 1 metre and the current 10 mA. The voltage in almost all exposures was 70 KV, while the exposure time varied between 2 and 20 minutes, depending on the film and the thickness of sound metal. A number of swords were so badly corroded that not enough of the pattern could be distinguished to determine the pattern types. These are recorded in the column(P) in Table 7.1 at the end of the chapter. This category also includes some swords with unusual patterns which do not fall into the categories. Inscriptions were found on both sides of the blade so that the images of both were superimposed on a radiograph, making it very difficult to distinguish them. Stereoradiographs were therefore made of these swords, which showed the layers or inscriptions much more clearly. For this, two separate exposures were made (left and right), the x-ray source being moved about 100 mm across the width of the sword which remained in exactly the same position. The films were examined with a stereo viewer, being laid side by side (left and right as marked). This made it possible to see which inlaid shapes were on the top and bottom surfaces, or to see if two pattern layers were present. The same technique was used to distinguish different pattern layers, notably on the Sutton Hoo sword. A visual survey was also made of the corroded swords, many of which were splitting, as is shown in Fig. 7.3a, and the number of layers were recorded (Table 7.1). Xeroradiographs were made at the Royal Marsden Hospital by Dr R. Davis, providing an excellent image for a selected number of swords.

4. Results

In the present survey 142 Anglo-Saxon and Viking period swords found in the British Isles were examined. Nearly all the swords are in the collection of the Department of Medieval and Later Antiquities of the British Museum. It was found that more than half were pattern-welded, a small proportion had pattern-welded inscriptions on both faces and the remainder were without pattern-welded decoration of any kind. It is interesting to note that the blades of the inscribed swords from England were not pattern-welded, although the inserted letters themselves were patterned-welded. This seems to be true of most similar swords described in other studies and perhaps is further evidence for the decorative rather than functional purpose of pattern-welding. The results are recorded in Table 7.1, the swords being listed in registration order, and are summarised in Table 7.2. In Table 7.2 the swords are recorded according to their dates and constructional types. These types are discussed in detail in the next section.

i) The Construction Types

The swords were divided into groups according to the number of bands or main elements which could be seen on the radiographs. These groups were further subdivided on the basis of the arrangement of the straight and twisted sections. (See Fig. 7.2) The other groups included the swords with inscriptions and the seaxes. The British Museum's collection of seaxes was also examined and grouped as patterned and inlayed or non-decorated. It should be noted that almost all the patterned swords had non-patterned edges which were welded on, and the decorated seaxes had non-patterned back and cutting edges, which were also welded on.

Some swords are listed in Tables 7.1 and 7.2 as patterned (P): these either have patterns which cannot be distinguished clearly enough to fit them into one of the categories, usually because of their corroded state, but also because the pattern or structure of the sword is unusual and does not fit into the constructional types described below. For example, the

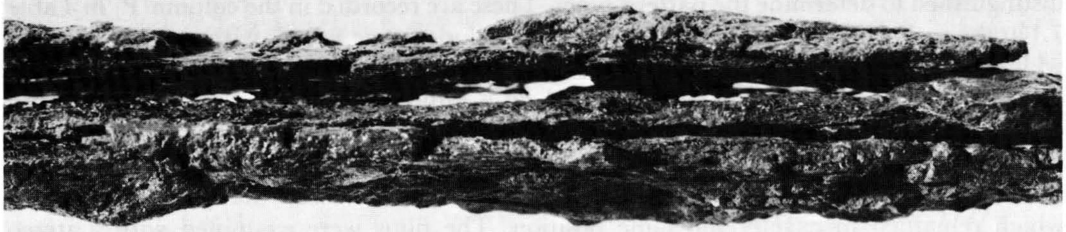

Fig. 7.3a Registration number 1936 5–11 54. Late fifth–Early sixth century Anglo-Saxon sword from Howletts, Kent, grave 16. This shows how the sword has split into three layers (two are patterned).

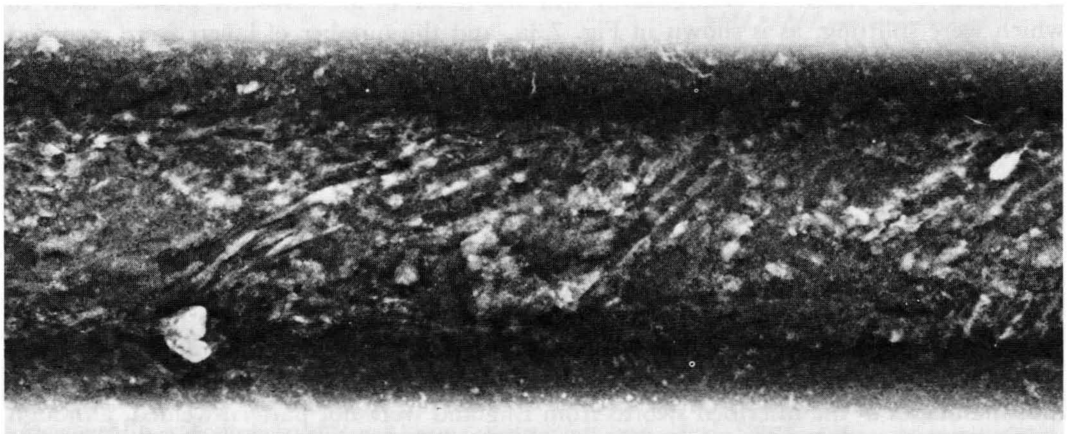

Fig. 7.3b Registration number 1869 3–15 1. Fifth–sixth century Anglo-Saxon sword from Waterbeach, Cambs. showing a broad diffuse surface band. Xeroradiograph by courtesy of the Royal Marsden Hospital.

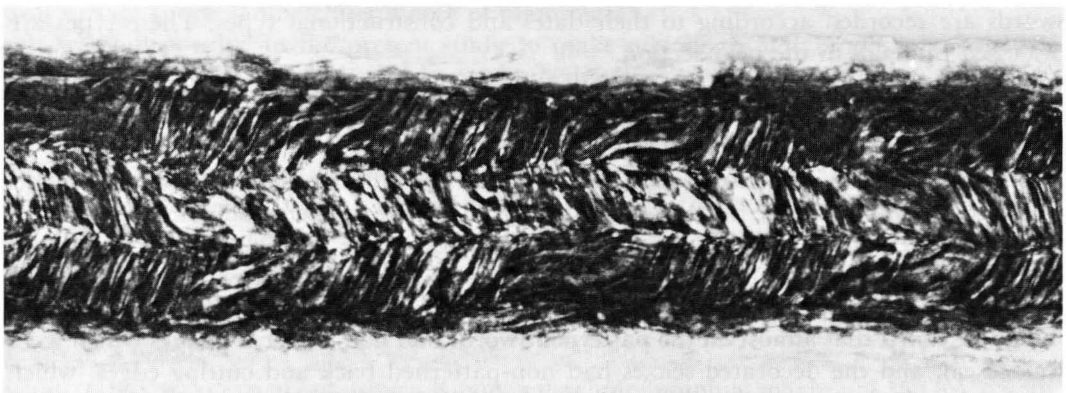

Fig. 7.3c Registration number 1912 7–23 1. Late ninth century Anglo-Saxon sword from Hurbuck, Durham, showing an unusual pattern with two layers of three continuously twisting rods, with a change in the pitch of twisting every 30–40 mm. A similar Anglo-Saxon patterned sword was found at Borgstedt in Schleswig-Holstein. Xeroradiograph by courtesy of the Royal Marsden Hospital.

Table 7.2 Frequencies of welding patterns according to date of swords.

Date	A	B1	B2a	B2b	C1	C2a	C2b	T	2 layer	P	O	total P	total	no. type	undec.	dec.	cent. A.D.
400–500	2	2	4	2	–	1	–	–	2	4	19	15	34	9	–	–	5–6
400–700	1	1	2	1	–	–	–	–	2	1	3	9	5	6	–	–	5–7
500–600	1	7	6	5	–	2	1	–	8	3	7	24	31	9	1	–	6
500–700	1	1	4	–	–	–	–	–	–	1	1	7	8	4	4	–	6–7
600–700	4	3	2	3	–	1	1	–	6	1	–	15	15	7	–	1	7
800–1000	2	2	–	1	1	1	–	8	3	3	4	10	22	7	7	8	9–10
Totals	11	17	18	12	1	6	2	8	21	13	34	76	119	–	12	6	

fifth–sixth century sword from Waterbeach, Cambs. (1869.3–15.1) (Fig. 7.3b) is the single example in the British Museum's collection of a broad diffuse band which spiralled around the blade; it resembles the blade made by Anstee and Biek (1961) by twisting a bar with a rod on either side, and could have been made by this method. A similar type of pattern was found on a sword from Waal-bij-Nijmegen (Ypey 1973). Two swords (1936.5–11.76, Howletts early sixth century and 1929.2–6.1 from Windsor, Viking tenth–eleventh) exhibited an interlace pattern on the radiographs; this might have been achieved by less frequent twists along the bar than was usual. The central element of the sword from Windsor was made by using two wires or strips together, arranged as a series of flattened loops (see Figs. 7.4a, 7.5a). Another example of individual variation is shown by a sword from Hurbuck (1912.7–23.1, Fig. 7.3c) which has a triple continuously twisting pattern, but at intervals of about 25 mm along each strip composite, the twist is much wider making a variation in the pattern. In contrast, the simplest variation was found: for example, three fifth–sixth century swords (two from Mucking 618, and one from Kempston 1891.6–24.79) were made from three strips, welded together side by side but were otherwise unpatterned. The central sections appeared to be strongly striated on the radiographs and could have presented a visual contrast with the smoother surfaced edges; this effect was often employed by late Iron Age smiths.

The preferred number of strips or strip composites used for the sword blades seems to have been three.

no. of elements	2	3	4	6
% of total number of pattern-welded swords	16	68	13	1

The reasons for this preference may be aesthetic or practical. It may be that it was found to be easiest to produce a sound blade with three strips or strip composites. Of course it is easier to twist a strip or rod with a thin cross section than a thicker one but once this has been done the strips still have to be welded together side by side, and this must have been an operation requiring some skill. The degree of difficulty increases with number and thinness of the strips, as there is an increasing danger of inclusion of oxides and incomplete welding.

It would be very difficult to ensure metallic contact as the twisted elements lay side by side ready for welding. (Anstee and Biek 1961, Maryon 1948, 1950). Gilmour's metallographic studies have shown that incomplete welding often did occur (Tylecote 1986).

The radiographs indicate that a number of strips or rods was used to make the strip composites, but it was extremely difficult to see how many were used in each bundle, so that it seemed better not to attempt to determine the numbers in most cases. For example the sword from Dover, grave C (1963.11–8.751) (see Fig. 7.5b) has straight sections made from three rod composites, lying side by side, each of which appears to consist of three thinner strips or rods, however it is possible that more strips are present in the bundle, but masked on the radiograph. Metallographic cross sections might provide answers to this question. Some of the corroded swords were examined visually and were found to be splitting into two or three layers. The results of this visual examination are given below.

Results

Patterned swords	3 layers 28	2 layers 5	1 layer 4
Non-patterned swords	3 layers 7		1 layer 6

It should be noted that this list is not exhaustive and represents a self selecting sample, ie. fairly severely corroded blades.

ii) Swords with two Pattern Layers

A number of swords with two layers of pattern were found by stereo radiography. These are noted below. As it is not easy always to detect two layers it is possible that some of the swords with very indistinct patterns may also be of this type. Of the 21 two layered swords found, 16 had similar patterns in both layers while five had different patterns. Two were from Faversham (nos 956–70, 957–70) with B2a and B2b patterns (see below for explanation), Lyminge (1890.9–2.1) with B2b and B1, Ardvonrig, Barra (1895.6–13. 22) with opposed B1 patterns in each layer, Howletts (1936.5–11.166) with B1 and a layer with strips running across the blade with B2a.

Note. The Sutton Hoo sword (1939.10–10.95,19–29) was the subject of a recent paper by Ypey (1983). He suggested that its arrangement of rods viewed in cross section could be described schematically either as

layer 1	SCSASCSAS or SSSSSSSSS
layer 2	SSSSSSSSS or SCSASCSAS

depending on the distance of the section along the blade (S = straight, C = clockwise twist, A = anticlockwise twist). A close examination of recent stereo radiographs, however, shows an arrangement which can be represented schematically thus, as

layer 1		layer 2
SCSC	or	ASAS
ASAS	or	SCSC

Fig. 7.4a Registration number 1929 2–6 1. Tenth–eleventh century Viking sword from the Thames at Windsor. This shows a straight part of the central loop with twists on either side and twisted cutting edges.

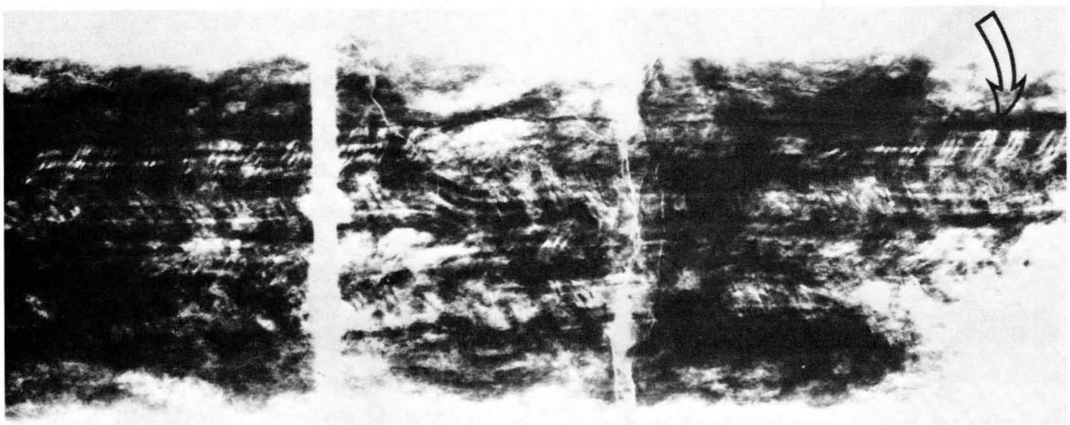

Fig. 7.4b Registration number 1939 10–10 95, 19–29. Seventh century sword from Sutton Hoo, Suffolk. This shows the two layered pattern. The area where the twist layers overlap slightly is arrowed.

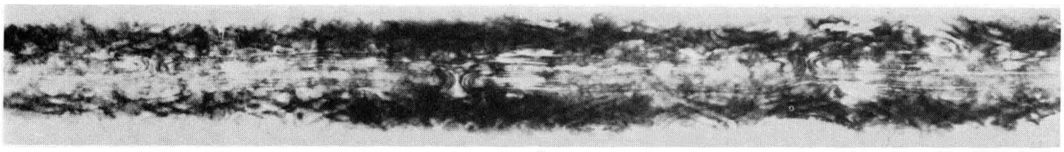

Fig. 7.5a Registration number 1929 2–6 1. Tenth–eleventh century Viking sword from the Thames at Windsor with superimposed loop pattern.

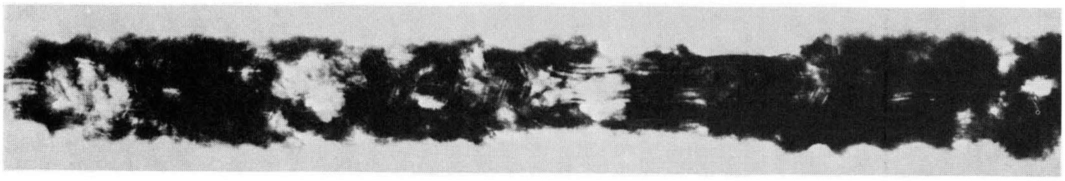

Fig. 7.5b Registration number 1963 11–8 751. 525–600 AD Anglo-Saxon sword from Dover, Kent, grave C, showing three bands clearly made from several strips in a coincident straight and twist pattern, with two layers, apparently not coincident.

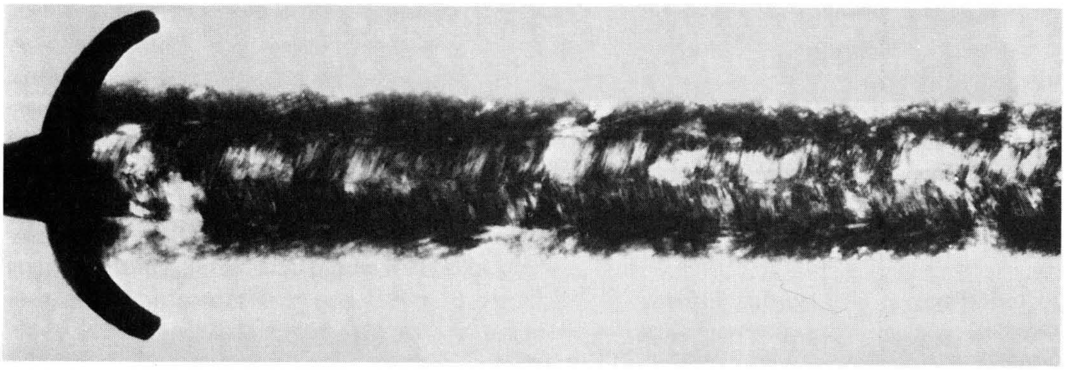

Fig. 7.5c Registration number 1856 7–1 1405, Anglo-Saxon ninth–early tenth. This sword has a typical two band continuous twist pattern.

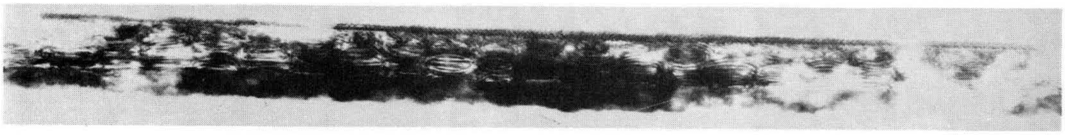

Fig. 7.5d Registration number 1912 7–23 2. Late ninth century Anglo-Saxon seax from Hurbuck, Durham, this was found with the sword (1912 7–23 1); it shows an unpatterned separate edge, a central section with whorls merging into an interlace region adjoining the back edge which has an inlaid plait.

depending on the distance of the section along the blade (Fig. 7.4b). Reproduction of the radiograph (Bruce-Mitford 1978, fig. 211) is poor and could be considered misleading.

Lists of the swords in each constructional group are given below. A double layered construction is indicated by: +

Type A Two Bands
The bands are twisted in opposite directions for the whole length:

1839.10–29.144a Chartham Down, Kent AS 7
1856.7–1.1405 London AS 9–E10 (Fig. 7.5c)
1891.6–24.80 Kempston, Beds AS 5–7
+ 1895.6–13.22 Ardvonrig, Barra AS 9
1902.7–22.171 Droxford, Hants AS 5–6
1936.5–11.164 Howletts, Kent AS 5–6
1963.11–8.416 Dover (gr 71) Kent AS earlier 7
1963.11–8.483 Dover (gr 93) Kent AS 6
1963.11–8.502 Dover (gr 96a) Kent AS earlier 7
1963.11–8.509 Dover (gr 96b) Kent AS earlier 7
1963.11–8.782 Dover (unassoc.), Kent AS 6–7

Type B Three bands
B1 Each band is twisted for its whole length usually in opposite directions:

+ 953–70 Faversham, Kent AS 6
955–70 Faversham, Kent AS 5–6
+ 1839.10–29.144b Chartham Down, Kent AS 7
*1853.4–12.89 Barham Down, Kent AS 6–7
*1853.4–12.90 Barham Down, Kent AS 6–7
1869.10–11.13 Chessell Down, IOW AS 6
1869.10–11.17 Chessell Down, IOW AS L5–6
1880.5–21.1 Longbridge, Warwicks AS 6
+ 1890.9–2.1 Lyminge, Kent AS 6(?)
1891.6–24.78 Kempston, Beds AS 6
1902.12–16.2 Windmill Hill, Bucks AS L5–6
+ 1912.7–23.1 Hurbuck, Durham AS L9–E10
+ 1912.12–20.2 Twickenham (?), Surrey AS 7
+ 1936.5–11.166 Howletts, Kent AS 5–6
+ 1963.11–8.174 Dover, Kent AS 7
1964.7–2.381 Gt Chesterford, Essex AS 6

* These are parts of one sword.

Type B2a Three bands with coincident twist and straight sections across the width.

+ 954–70 Faversham, Kent AS 6
+ 956–70 Faversham, Kent AS L5–7
+ 957–70 Faversham, Kent AS 6
1848.7–27.1 Battle Edge, Burford, Oxon AS L5–E6
1867.7–29.150 Chessell Down, IOW AS c500
+ 1873.6–2.104 Tissington, Derbyshire AS 7
+ 1875.3–10.40 Long Wittenham, Oxon AS 6
1883.12–13.612 Sittingbourne, Kent AS 6
+ 1888.7–19.57 unprovenanced AS 5–7
1894.11–3.1 Crundale Down, Kent AS 7

+1894.12–16.4 Broomfield, Essex AS 6–7
+1936.5–11.99 Howletts, Kent AS 6
1963.11–8.124 Dover, Kent AS 5–6
1963.11–8.281 Dover, (grave 41), Kent AS 6–7
1963.11–8.340 Dover, Kent AS 6–7
1963.11–8.493 Dover (grave 94b) Kent AS 6–E7
+1963.11–8.751 Dover (gr C) Kent AS 6
1963.11–8.783 Dover, Kent AS 6–7

Type B2b Three bands, with alternating straight and twisted sections along the length and across the width.

952–70 Faversham, Kent AS 6
+956–70 Faversham, Kent AS 5–7
+957–70 Faversham, Kent AS 6
1869.10–11.16 Chessell Down, IOW AS L5–6
+1873.6–2.104 Tissington, Derbyshire AS 7
1883.12–13.621 Sittingbourne, Kent AS E7
1887.2–9.1 London V 10–E11
+1890.9–2.1 Lyminge, Kent AS 6
1915.5–3.2 Herringswell, Suffolk AS 5–6
1915.12–8.353 Astwick, Beds AS 5–6
1963.11–8.128 Dover (gr 27) Kent AS E7
1963.11–8.469 Dover (grave 91) Kent
1963.11–8.603 Dover (grave 131) Kent A E7

Type C Four bands
C1 Four bands of continuous twist (Emmerling's M or W forming type)

1854.11–7.12 Norwich AS L 9–E10

C2a Four bands of coincident twist and straight sections across the width

OA 6610 Barnet, Herts AS 5–7
+1875.3–10.40 Long Wittenham, Oxon AS 6
+1883.12–13.646 Faversham, Kent AS 6
+1883.12–14.4 Taplow, Bucks AS E7
1894.8–3.87 Strood? Kent AS 5–6 (Fig. 7.6a)
+1965.7–3.1 Wensley, Yorks. AS 9

C2b Four bands of alternating twist and straight sections across the width and along the length
1936.5–1.75 Howletts, Kent AS 6

+1939.10–10.95, 19–29 Sutton Hoo, Suffolk AS E7

Type F2b Five bands

1913.7–17.1 Barlaston, Staffs AS 7
1963.11–8.511 Dover, Kent AS 6–E7

Type P
a) Pattern present but not identified

1891.6–24.79 Kempston, Beds AS 5
1902.7–22.175 Droxford, Hants AS 5–6
1906.6–12.1 Farnden, Notts 9–10
1936.5–11.99 Howletts, Kent AS 5–6
1936.5–11.165 Howletts, Kent AS 5–6

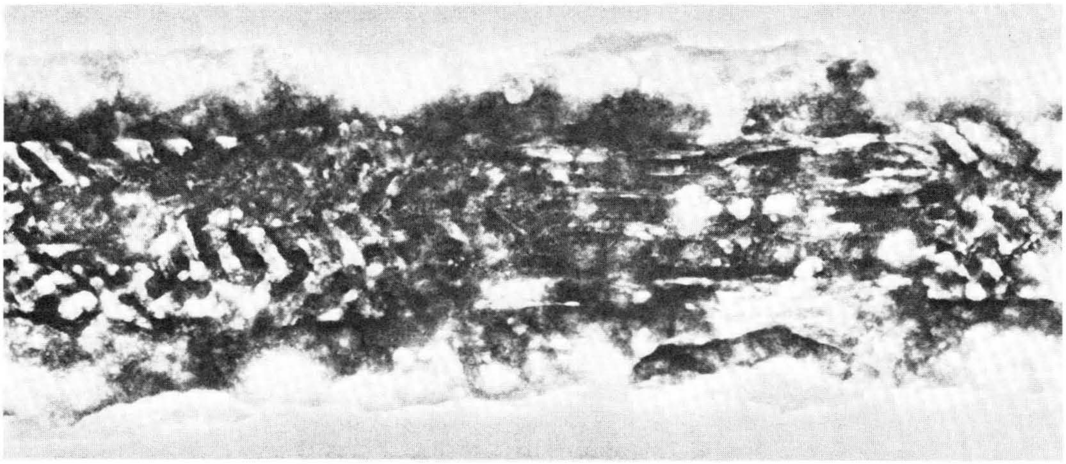

Fig. 7.6a Registration number 1894 8–3 87. Later fifth–sixth century Anglo-Saxon sword from Strood, Kent, showing four coincident bands of straight and twist. Xeroradiograph by courtesy of the Royal Marsden Hospital.

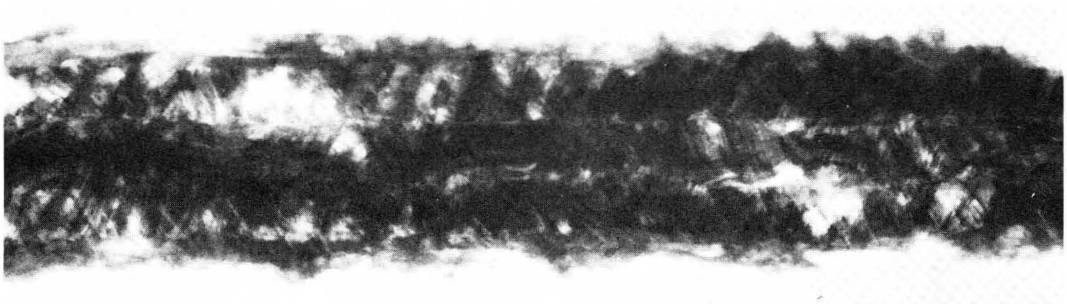

Fig. 7.6b Registration number AL116/775. Ninth century Viking sword from the Thames at Windsor. This shows two layers with three twisted bands in each, the central band having an elongated twist at intervals.

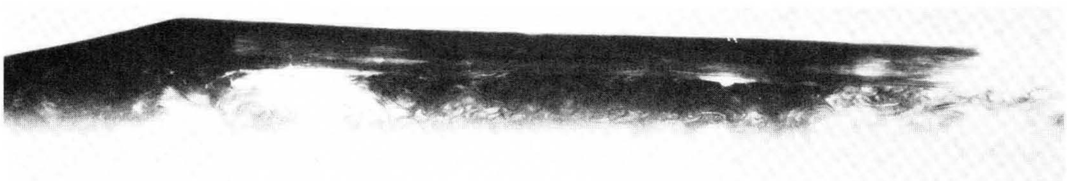

Fig. 7.6c Registration number 1856 7–1 1408. Anglo-Saxon seax (ninth–tenth century).

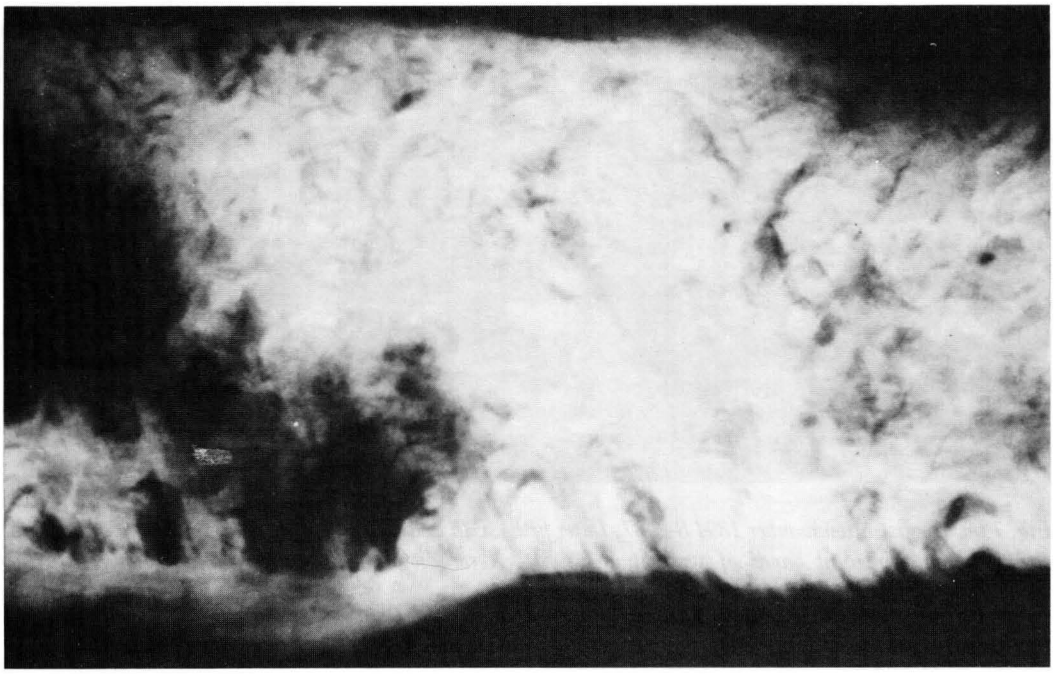

Fig. 7.7a Registration number 1894 11–3 1. Mid seventh century Anglo-Saxon sword from Crundale Down showing curving elements in the pattern near the tip of the blade.

Fig. 7.7b Registration number 1848 10–21 1. Late ninth or early tenth century Anglo-Saxon sword from the R. Witham at Lincoln. This shows part of the inscription, with the S-scroll on the reverse clearly visible.

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b) Unusual patterns

Acklam sword (Yorkshire Museum)
This sword has six bands of alternating twist and straight, probably in two layers.

AL 116/775 Thames, Windsor V 9 (Fig. 7.6b)
(British Museum sword, on loan to the Royal Armouries, Tower of London) This has a two layer structure, with three bands of twist in each layer. The middle band in each layer has an elongated twist at about 3 cm intervals. The two layers are not entirely coincident.

1839.10–29.144b Chartham Down, Kent AS 5–6
This has a two layered structure with three bands of continuous twist in each layer. One layer also contains some short straight sections.

1854.11–7.12 Norwich AS 9–E10
This sword has four elements, giving a herringbone pattern of continuous twists. Visual inspection of the sword itself suggests that there may be two layers.

1869.3–15.1 Waterbeach, Cambs AS 5–6 (Fig. 7.3b)
This sword has an unusual diffuse pattern and was discussed above.

1869.10–11.13 Chessell Down, grave 26 IOW AS 6
This sword has a patterned strip down the middle, consisting of three continuously twisting bands, with two straight strips on each side.

1894.11–3.1 Crundale Down, Kent AS 7 (Fig. 7.7a)
This sword has two layers of non-superimposed twist and straight, of type B2a. The twists become very tight near the tip and take a cruciform pattern, which suggests that that area has been ground.

1895.6–13.22 Ardvonrig, Barra AS 9
This sword has a two layered pattern with two continuously twisting bands in each. The two layers, unusually, appear to be in oppostion, thus;
1st layer C A
2nd layer A C

1912.7–23.1 Hurbuck, Durham AS L9 (Fig. 7.3c)
This sword has two layers consisting of three continuously twisting bands, not completely superimposed. The bands have a longer twist at intervals, and have been arranged to coincide across the width.

1913.7–17.1 Barlaston AS 7
Fragmentary sword which appears to have 5 bands of twist, possibly with some straights alternating across the width, probably two layers of pattern.

1929.2–6.1 Windsor V 10 (Fig. 7.4a, 7.5a)
The whole blade appears to be patterned including the cutting edges. It has been constructed from two narrow twisted sections forming the cutting edges, next to them are two broader twisted sections, and in the centre a band made from a continuously looped strip of metal. The plate shows that each band is made up of a number of thin strips.

1936.5–11.76 grave 20, Howletts, Kent AS E6
This sword apparently does not have separate edges but has a long continuously twisting pattern, in which it is difficult to distinguish the number of elements.

1936.5–11.166 Howletts, Kent AS 5–6 (Fig. 7.8)
This sword is fragmentary, but the remains showed two layers, one consisting of three bands of continuous twist (B1), while the other showed partly B2a structure, but with cross bands (cutting edge to cutting edge) for part of the length.

Type I Inscriptions
Lyle collection cat.no 236 (not available at British Museum)

Westminster, Thames AS 10–E11

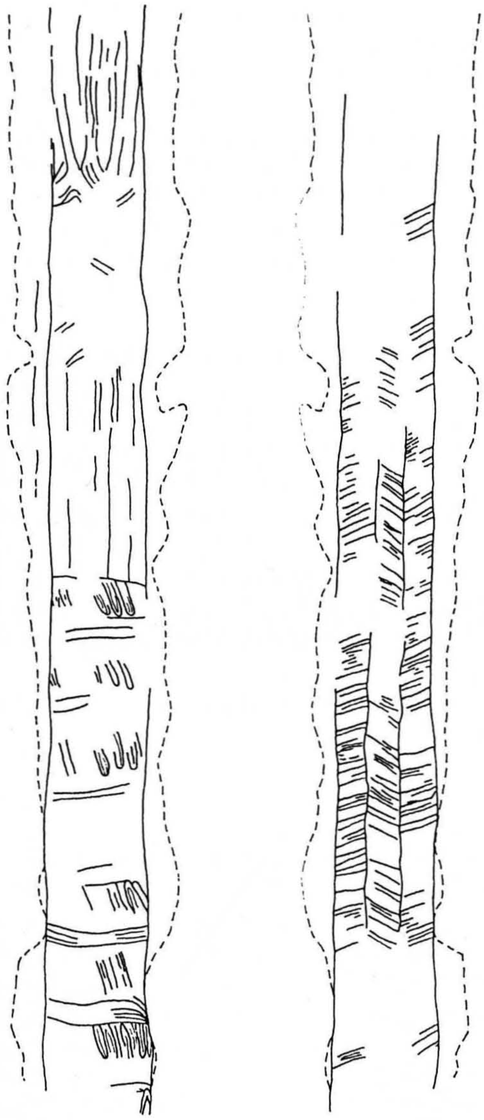

Fig. 7.8 Drawing from the radiographs of reg. no. 1936 5–11 166 from Howletts, Kent.

Tr 169 No provenance AS L10–11*
Tr 174 Nottingham V E10*
1848.10–21.1 Lincoln AS 10
1856.7–1.1404 Temple, Thames V 10–11
1864.1–27.3 Lough Gur, Grange, Co. Limerick, Ireland V 10
1875.4–3.169 Burneston, Yorks AS 9
1891.9–5.3 Kew, Thames V 10
1915.5–4.1 Edmonton, Middx V 10

* on loan from the Royal Armouries

iii) Inscriptions

As the lists given in the preceding sections show, in England true pattern-welded blades continued to be forged by Anglo-Saxon swordsmiths into the late ninth and early tenth centuries, i.e. swords of Petersen's type L (Petersen 1919, 112–6; his typology is based on the form of the hilt, not on the pattern-welding of the blade). Meanwhile, on the Continent, a new type of blade of plain steel, not pattern-welded, but often carrying ferrous inlaid pattern-welded inscriptions of various forms (see below), had already come into production as early as c. 800 AD. This type had largely replaced the pattern-welded blade during the course of the ninth century (Müller-Wille 1970, 82; 1982, 135–7, 145–9) During the ninth century the new form of blade appears in England. It seems, from the limited number of examples surviving, to have taken over by the end of the century and some may even have been made here (Evison 1967, 181).* These inscribed blades can be seen as an end refinement of the technique of pattern-welded veneering (Fournierdamast) described by Menghin (1983, 17–18). In this process, thin pattern-welded sheet was inlaid on blades of otherwise homogeneous steel. It was adopted on the continent towards the end of the Merovingian period, apparently purely for decorative effect, but does not seem to have been much favoured in England.

On the continental blades, the inscriptions usually took the form of a name in large Roman capitals in the fuller of one side (towards the hilt end) and of a pattern-welded design or motif on the side immediately opposite; or, less often, of motifs alone on both sides. By far the commonest of these inscriptions are renderings of the names "Ulfberht" (Müller-Wille op.cit., and 1977; East and Brown, forthcoming), and "Ingelrii" (for both see also Lorange 1889, 12–20; Wegeli 1902–5; Petersen 1919; Davidson 1962, 42–50; Kirpichnikov 1966 and 1969; Evison 1967, 177–83). From the numerous repetitions of the same name, they seem originally to have been makers' (not owners') names from the middle Rhineland. In another area this is explicitly stated on an eleventh century late Russian sword from Foshchevatya which bears, in pattern-welded Cyrillic letters, a name on one side and the slavonic word for "smith" on the other (Kirpichnikov 1966 41, figs. 14–15; 1969, 176–7, figs. 6–7). Furthermore there are also the well-known non-ferrous inlaid inscriptions with both makers' and owners' names (e.g. the Sittingbourne seax, Wilson 1964, 172–3). Typological studies based on the hilts show that the names Ulfberht and Ingelrii were in use over several generations, into the eleventh and (in the latter case) even twelfth centuries. Each was probably first used in just one workshop, but once they became recognised as marks of good quality blades they were probably imitated at other centres. Indeed, one sword from the Old Nene near Peterborough appears to carry both the name "Ingelrii" on one side and, less certainly, "Ulfberht" on the other (Ypey 1960–1, afb, 30; Davidson 1962, 47; Müller-Wille 1970, no. 11 on p. 84). The motifs seem to have served as a kind of trade mark, either alone or on the reverse of the name blades. The distribution of inscribed sword-blades, largely in grave and river finds right across northern and central Europe from Iceland and Ireland to the Dnieper and middle Volga results from the combined effects of both trade and warfare.

The inscriptions appear to have been made by hammering short lengths of plain or twisted wires into a chased channel in the surface of the blade while it was white-hot. The characters were secured in place by further hammering after reheating (Davidson 1962, 45). There is some evidence to show that a form of punch was also used to drive the inlays

* "those with inlaid pattern-welded figures" although "it is not impossible that one or more [of bad copies of Ulfberht and Ingelrii] may have been Anglo-Saxon copies".

into position (East, 1985). Finally the surface was ground smooth and polished so that the patterned metal of the inlay contrasted with the plain steel of the blade. Modin (unpublished report) found that the pattern-welded letters on an Ulfberht blade (from Claud, Hulterstad, Sweden) were pattern-welded from ferritic iron which might have contained phosphorus. This would have remained bright and shiny while the blade dulled.

Often the inscriptions are still visible, or if obscured by corrosion can be revealed by cleaning and treatment (Maryon 1950, pls. 21–2; Oakeshott 1951, pl. 14; Kirpichnikov 1969, 170). Where this is not possible, examination by x-radiography (Fig. 7.7b) can prove invaluable and the present study has added a further five inscriptions to the corpus which were not otherwise visible to the naked eye (nos. 2, 3 and 7 below). All the pattern-welded inscriptions are discussed in more detail below.

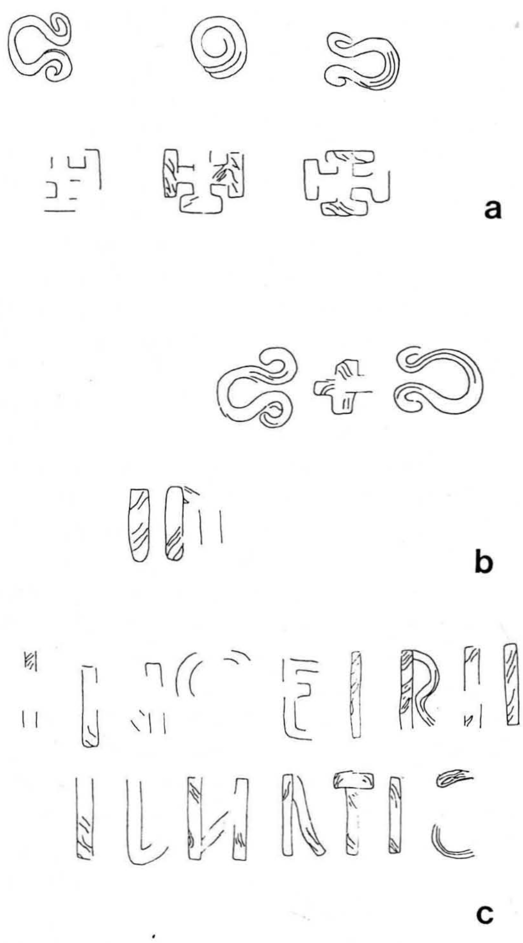

Fig. 7.9 Pattern-welded inscriptions drawn from radiographs: a) Lyle collection no. 236 (R. Thames near Westminster); b) Reg. no. 1915 5–4 1 (R Lea at Edmonton, Mddx); c) Reg. no. 1891 9–5 3 (R Thames at Kew, Surrey).

1891, 0905.3.a

1 *Sir Gavin Lyle's Collection, Cat. no. 236 (River Thames near Westminster)*
(Fig. 7.9a. Sir Gavin Lyle's Collection, Cat. no. 236); Wilson 1965, 42, no. 10 and fig. 13. Evison's Wallingford Bridge type; 10th–earlier 11th cent. (Evison 1967, 186). Stereo radiographs show that the published figure of the inlaid marks can be improved on and that the 'inscription' is in fact double-sided. It consists of an eyelet loop either side of a spiral scroll on one side and three crosses potent on the other. This arrangement is one of several ninth–eleventh century variations using similar loops and crosses in groups of three. Another sword of Wallingford Bridge type from Lempäälä, Finland, carries a cross potent between eyelets on one side and a spiral scroll between two similar crosses on the other (Leppäaho 1964, Taf. 10, 2). Related marks can also be seen on a sword of Petersen's type Z from Neuzvestno and on another of Petersen's type E from Ust'-Ruibezhna, Russia (Kirpichnikov 1966, fig. 18, 3 & 8; for dating see Stalsberg 1981). The different arrangements of symbols may indicate different workshops, or it could be that they are simply variant marks of one centre. The same symbols, but with wholly different patterns on the reverse, are used on swords of Petersen's type E from Gnezdovo, Russia (Kirpichnikov 1966 fig. 18, 7) and of type R or S from Lempäälä, Finland (Leppäaho 1964, Taf. 9, 4) while a circle and cross potent on a type Z sword from Kangasala, Finland are perhaps all that remain of a similar inscription (ibid., Taf. 9, 2). A plain equal-armed cross between the eyelets can be seen on an early tenth cent. sword from Edmonton (inscription no. 9, below; Fig. 106). Penannular and scrolled loops of rather different forms appear on swords of the ninth cent. from Maarhuizen and Wijk-bij-Duurstede, Holland and one of tenth cent. from Brekendorf, Germany (Ypey 1960–1, afb. 12–13, 16–17; Müller-Wille 1977, Abb. 13, 5). There appears to be a relationship, perhaps of imitation, between inscriptions combining crosses and eyelets, but without names, on the one hand, and the pattern of horse-shoe loops on either side of a cross crosslet on an ULFBERHT sword from Rapola, Finland on the other (Leppäaho 1964, Taf. 16c; Müller-Wille 1970, 87, no 78).

2 *Tr 169 On loan from the Royal Armouries, Tower of London (No provenance)*
(Fig. 7.10a. B.M., on loan from the Royal Armouries, no. Tr. 169). This is a sword of Petersen's type Z of the later tenth–eleventh cent. (Evison 1967, 171). The inscription is possibly only single-sided: a circle or C-scroll between groups of transverse bars, cf. a sword (of Petersen's type O?) from Myklebost, Norway (Lorange 1889, Tab. 3, 6).

3 *Tr 174 On loan from the Royal Armouries, Tower of London (Nottingham, Notts.)*
(Fig. 7.10c. Anon 1851, p. 425 central figure). This is a Viking sword of c. 900–950 belonging to Petersen's type X with a short guard. A C-shaped loop is all that remains of the inscription on this sword, which may originally have been a C between two reversed Ns, as on a tenth to eleventh cent. sword of the Wallingford Bridge type from the Thames (Evison 1967 pl. 9 and figs. 1f and 5a), or it may be part of the 'G' in 'INGELRII', although this is perhaps less likely because there is no trace of other letters.

4 *Reg. no. 1848 10–21 1 (R. Witham at Lincoln)*
(Fig. 7.11a. Maryon 1950, pls. 21–2 Wilson 1964, cat. no. 32, with full bibliography).This is a sword of Evison's Wallingford Bridge type, perhaps of an early stage and is dated late ninth or early tenth cent. by Wilson (1965, 44) although the absence of Trewhiddle style silver plates usual on later ninth–early tenth cent. Anglo-Saxon swords noted by Evison

Fig. 7.10 Pattern-welded inscriptions on sword blades drawn from the radiographs: a) Tr 169 (unprovenanced); b) Reg. no. 1875 4–3 169 (Camphill, Burneston); c) Tr 174 (Nottingham).

(1967, 163) would seem to place it within the tenth century. The inscription is double sided; side (a) +LEUTLRIT (with an inverted final T); side (b): reversed S-scroll. The name is Continental Germanic and is probably to be read Leuterit/Leutirit or Leutfrid, or perhaps Liudrid (Page 1964, 90). Evison (1967, 180–1) notes two other blades with this inscription from Estonia and Russia and a possible Anglo-Saxon copy from the Thames at Battersea. A reversed S-scroll, (although with the addition of tendril terminals), is seen on another sword from Al'myet'yevo, Russia, with an indistinct symbol on the reverse (Kirpichnikov 1966, fig. 21).

5 *Reg. no. 1856 7–1 1404 (R. Thames opposite the Temple, London)*
(Fig. 7.11b. Oakeshott 1951, fig. 1 and pl. 14; Davidson 1962, fig. 28, 30; Evison 1967, pl. 12a). This is a sword of Evison's Wallingford Bridge type of tenth or earlier eleventh cent. and has a double-sided inscription; side (a): INGELRII; side (b): a cross potent flanked by groups of triple bars. References to other 'Ingelrii' swords are given above.

6 *Reg. no. 1864 1–27 3 (Lough Gur, Grange, Co. Limerick, Ireland*
(Fig. 7.11c. Bruce-Mitford 1953, 321; Davidson 1962, fig. 27). This is a sword of Petersen's tenth cent. type Q, and has a double-sided inscription; side (a): a cross potent between horseshoe-shaped loops with rings at the terminals and flanked by groups of triple bars either side; side (b) a circle between crosses potent and groups of triple bars either side. Evison (1967, 179 no.75) compares this inscription with an almost identical one on a ninth–tenth cent. sword from Loppi, Finland.

7 *Reg. no. 1875 4–3 169 (Camphill, Burneston, North Yorkshire)*
(Fig. 7.10b). This is an Anglo-Saxon sword of the later ninth century belonging to

Petersen's L type and has a single figure of eight loop inlaid lengthwise on either side of the blade towards the hilt end. The loops are of similiar size but are not directly opposite to each other and one begins about 8 mm further down the blade, so that they overlap on the x-ray. As it stands the pattern appears to be unique, but it can be compared with the figure of eight loops set transversely between groups of triple bars on two Ulfberht swords from Vad and Visnes, Norway: the former is of Petersen's tenth century type R and the latter is of his ninth to mid tenth century type H (Müller-Wille 1970, Abb. 6, 25 and 7, 30). The pattern may also be related to the simple lengthwise knot between bars on another Ulfberht sword from Sassinsaari, Finland (ibid. Abb. 8, 76) and, less closely, to the pair of-apex-to-apex triangles between triple bars on a type H sword from Shestovitsy, USSR (Kirpchnikov 1966, fig. 17, 6) and to the similar pattern on an Ingelrii sword from the Thames at Wandsworth (Evison 1967, fig. 4a). The loops of the Camphill sword possibly

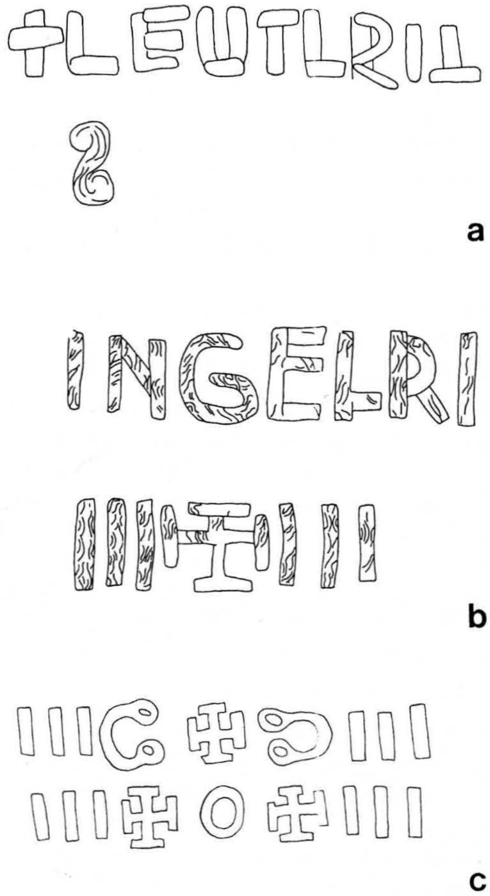

Fig. 7.11 Pattern welded inscriptions on sword blades drawn from the radiographs: a) Reg. no 1848 10–21 1 (R. Witham at Lincoln); b) Reg. no 1856 7–1 1404 (R. Thames at The Temple, London); c) Reg. no 1864 1–27 3 (Lough Gur, Co. Limerick, Ireland).

then represent an Anglo Saxon attempt to imitate the Continental marks incorporating similar motifs.

8 *Reg. no. 1891 9–5 3 (R. Thames at Kew)*
(Fig. 7.9c. Unpublished). The pommel is missing, but the brass-inlaid guards are close in form to those of Petersen's type Q of the tenth cent. and lasting into the later Viking period. A double-sided inscription is obscured by scabbard remains and accretions. Superimposition of letters on the x-ray plates makes it extremely difficult to read and the following interpretation is purely tentative: side (a) INGELRII; side (b) SITAN(B)I if (a) is read correctly, or possibly I(B)NATIS if not. The name INGELRII occurs frequently in blade inscriptions (see above), but the reading of side (b) is so uncertain that it seems pointless to speculate further than to say that it may be the name of the owner. Although the maker/owner formula appears to be unknown on the Continental sword blades of the period under discussion it can be paralleled on the ninth–tenth cent. Anglo-Saxon seax from Sittingbourne, Kent, except that in the latter, the inscriptions are incised on inlaid plates on one side and inlaid in silver on the other (Wilson 1964, cat. no. 80, pl. 30). In his account of a sword of Petersen's type X of the tenth or beginning of the eleventh century from Den Hool, "Oosterhesselen", Holland, which has a different inscription on either side of the blade (viz. INGERIH FECIT and SIGBRHANI), Ypey (1984) makes the alternative suggestion that the use of the two different names could have been to deceive the purchaser into thinking that these blades were of especially high quality. In support of this suggestion he comments on the number of imitations of maker's names that were prevalent.

9 *Reg. no. 1915 5–4 1 (Old bed of R. Lea at Edmonton, Middx)*
(Fig. 7.9b; Read 1915; Shetelig 1940, fig. 25; Davidson 1962, fig. 69). This is a Viking imported sword of Petersen's tenth cent. type U; its metal inlays date it early in this period (Wilson 1966, 44). Double-sided inscriptions: side (a), a pair of eyelet loops with scrolled ends flanking a plain equal-armed cross; side (b), two transverse bars only, but nothing more of the pattern can be seen. The closest parallels, though both with crosses potent instead of the plain form, are on the swords from Lempäälä, Finland and Ust'-Ruibezhna, Russia mentioned under no. 1 (Leppäaho 1964, Taf. 9. 4 and 10, 2; Kirpichnikov 1966, fig. 18, 8).

10) 1873, 12-19, 233 - Hoff, NY : 3 gps of bars sep'd by 2 zones of lattice pattern

iv) Seaxes

Twenty seaxes were examined fourteen of which were dated to the ninth or tenth centuries. Nine of the blades had pattern-welding or inlays which were non ferrous. The blades consisted of three sections, the back edge, the patterned middle section of the blade, and the hammered cutting edge, although the simplest forms appeared to have been made from only one or two pieces of metal, rather than three.

The forms of the decoration were:-

(a) Pattern-welded strip inlays (1857.6–23.1) and Oliver's Battery Hampshire, on loan from Hampshire County Council.
(b) Welding (1856.7–1.1408 (Fig. 7.6c), 1912.7–23.2 (Fig. 7.5d), possibly 1883.12–12.1).

(c) Non ferrous inlay (copper and brass) as a braid (1912.7–23.2, 1856.7–1.1413, 1859.1–22.12, 1881.6–23.1, 1857.6–23.1) the seax from Sittingbourne (1881.6–23.1) also has an inscription.

Four of the remaining blades were made from a blade section and a back-edge section, the latter having one or more grooves, running parallel to the edge of the blade. The radiographs showed that the blade consisted of two sections, the back edge was strongly striated, with the grain running parallel to the edge while the blade section showed a less directional, more uneven appearance, with rounded areas of less radiographic density, which is typical of hammered metal. This suggests that after the two segments of the seax had been welded together, the blade was forged out to the required shape. Two seaxes appeared to have been made from a single piece of metal, but had grooves, while three were also from a single piece of metal, but were completely undecorated. The construction of the remaining two could not be determined.

5. Discussion

The discussion section is in two parts. The first is concerned with comments or observations arising directly from the radiography results, while in the second part there is a more general discussion on the purpose of pattern-welding, the origins of the swords and the social or economic changes which might be inferred from the results.

(A) Comments on the results

1. 64% of the Anglo-Saxon and Viking period swords examined are pattern-welded.

2. The proportion of swords with pattern-welded blades rose dramatically after about 500 AD. and fell again during ninth–tenth centuries.

Table 7.3 Pattern-welded swords, percentages according to date.

Centuries AD	5–6 AD	5–7	6	6–7	7	9–10
% all swords coming from all sites	44	55	77	88	100	45 pw

From the table it can also be seen that:-

(a) The proportion of patterned to non-patterned swords rose to a peak during the seventh century.
(b) No sword-blades which could be firmly dated to the eighth century have been found.
(c) Making swords with pattern-welded inscriptions was restricted to the period after 800 AD.

3. In the British Museum sample, the use of the two patterned layered structure seems to have been mainly in the sixth and seventh centuries. Anstee (1961) listed 21 Anglo-Saxon

swords, all but one of which had double layers. Gilmour (Tylecote 1986) has also sectioned 18 swords from fifth–seventh centuries, all of which were found to have two patterned layers. However in the British Museum sample only 58% of patterned swords were identified as having two layers. This difference may be the result of the difficulties of identification when radiographs alone are used.

4. A total of 141 provenanced swords were found and 43 of these came from Kent. The cemeteries in East Kent represented here by Dover, Faversham, Crundale Down, Sittingbourne, Howletts, Lyminge, Chartham Down and Barham Downs are noted for their rich furnishings, not least the swords. The Dover site was remarkable, not only because it produced 17 swords, but also, because all of them were patterned. On the other hand Mucking (Essex) yielded 5 swords none of which was patterned. Similarly only two of the 6 Droxford (Hants) swords had a pattern (1902.7–22.171 and 175). Of the swords found in Kent, 89% were patterned while only 31% of the swords found in other locations were decorated.

Table 7.4 Percentages of pattern-welded swords from Kent.

Centuries AD	5–6	5–7	6	6–7	7	9–10
% All swords coming from Kent	20	44	83	75	47	–
% All decorated swords from Kent	40	20	66	75	47	–
% Kent sword decorated	86	50	80	100	100	–
% Other swords decorated	35	55	72	50	100	37 pw
inscript.						36

The reason for the Kentish sites being rich in pattern-welded swords may reflect the preferences and economic status of its inhabitants (or transients) and also its proximity to the Continent, in particular the Rhineland and Northern Germany, Denmark and Northern France, whose inhabitants made extensive use of pattern-welding. Kent already had a long tradition of iron working and it has been argued by Cleere (1983) that there was a Roman Imperial Estate in the Weald, with direct state working in the eastern part, though whether or not there was any direct continuity into the Anglo-Saxon period is not known as yet.

5. The results were also examined to see if there was any change in the number of pattern types being used which could be related either to the location of the finds or their chronology. A and B types were found throughout the period in most areas. The rich site at Dover (Evison 1987) yielded a total of 5 A type swords, 3 each of type B2a and B2b, and two F types, but none of the B1, C or D types. This suggests either some degree of aesthetic selection or that they came from the same workshop or group of workshops. Looking at the number of different patterns being used throughout the Anglo-Saxon period there was little change in the variety of the patterns on the swords. Seven different pattern types were recorded during this period. Comparison with material from other sites kindly made available by Sonia Hawkes, suggests that other more complex patterns, some with curving

elements, were being used in the fifth, sixth and seventh centuries. This material is being reviewed and it is hoped will soon be published.

6. The seax first appeared in the sixth century as an undecorated blade, but apparently did not come into common use until the ninth–tenth centuries.

Table 7.5 Percentages of decorated seaxes.

Date	Total no. of seaxes	Decorated welded or inlayed seaxes
6	1	0
6–7	4	0
7	1	1
9–10	15	8

Ten seaxes were found in London, and eight elsewhere. It is interesting to note that the decorated seaxes were later ones. Perhaps a weapon which was less costly to produce when it was introduced was adopted by wealthier clients who preferred patterned blades. Swords with inscriptions constituted 4% of the total number of swords during the whole period and 32% of those dating from the 9–11th century; four were found in the London area, and one each in Ireland, in Lincoln, in Yorkshire and in Nottingham.

(B) General discussion of pattern-welded blades

Three questions arise in connection with the pattern-welded blades. These are:

(1) was pattern-welding decorational or structural in intention;
(2) were the blades made in England or imported from the continent;
(3) what social and technological changes taking place can be inferred from the swords themselves and their deposition.

The Purpose of Pattern-Welding

Pattern-welding has been considered to have been be employed mainly for strengthening the blade, but some recent papers suggest rather that it was used mainly for decoration and a consensus of opinion seems to be gradually emerging to this effect. Tylecote (1962 p. 250) remarked that the pattern was a by-product of the method of manufacture and not an intended effect. It was used, he suggested, to introduce carbon into the blade to a greater depth and thus to increase its hardness. At the same time the embrittling effect concomitant with increasing hardness would be mitigated by the softer tougher strips also incorporated in the pattern-welded structure, and gross slag inclusions would be also eliminated. Later, however, Tylecote (1976, p. 57) has commented that it is not clear that artifacts made in this way were appreciably stronger than most of the weapons made by simple piling, but if well polished, they would look beautiful. Most recently (1986), Tylecote said that the pattern-welded sword appears to have been designed in its earliest phase as an ornamental or prestige weapon and its military usefulness seems to have taken second place to its appearance. He adds "If it were not for the fact that we know that such swords were used for fighting (Beowulf etc) we would have supposed that its purpose was like the ceremonial sword of today."

Some early work supported the idea that the swords had superior properties; certainly Salin (1957) and France-Lanord (1947) found that the pattern-welded swords which they examined were extremely hard and apparently could cut like razors. France-Lanord (1947) also tested the blades he was examining and found that pattern-welded blades were three times more flexible than ordinary blades (Salin 1957, p. 65).

It is clear from Old Norse and Irish literature that the springiness of the blades was much valued in a good sword: the Svarfdaela Saga (Davidson 1962) describes how, ideally, the tip of a good blade could be bent back to touch the hilt and spring back undamaged. During conservation in the British Museum Conservation workshop a seventh-century pattern-welded sword in good condition from Acklam still exhibited considerable springiness when being straightened in spite of lying in the ground for fourteen centuries. Menghin (1983) also stressed the importance of pattern-welding and the resilience of the blade.

Although the resilience of the blade is important, pattern-welding is not necessarily the best way of achieving it. Ypey (1984), as a result of his own experimental work, has suggested that the purpose of pattern-welding was almost entirely decorative, at least in the later Carolingian and Viking periods. This must be the case with pattern-welded spearheads which are of rigid construction. Menghin (1983) has reported thin surface layers of pattern-welded material on sword blades which must be also entirely decorative, although it should not be forgotten that these developments are relatively late. So many swords have been identified as having three layers, a relatively plain layer (Schürmann 1959) between two pattern-welded ones, that it is difficult to believe that their presence is entirely functional. Cutting edges and cores were constructed from more than one strip (Schürmann 1959, Tylecote 1986) but often with a layered structure, and this was probably intended for stengthening. Gilmour (Tylecote 1986) sectioned a number of patterned-welded swords and found that the blades were variable both in relation to soundness and their hardness although there seemed to be a technical improvement from the eighth century onwards. The majority were made from wrought iron, both phosphorus rich and phosphorus free, while some contained some iron richer in carbon. Gilmour discussed the use of phosphorus iron, which he concluded was employed to improve the pattern, rather than for its structural properties. Phosphorus iron was frequently used during the Iron Age (Schultz 1965) and a Roman blowing iron was constructed from low and high phosphorus irons. In this case it was concluded (following Rollason 1978, 170) that these irons were used to facilitate welding (Lang 1976). If this were the case, it might have been a factor in its use in pattern-welding. Goodway (1987) also points out that phosphorus has a considerably hardening effect and in the absence of carbon can be worked and used satisfactorily. On balance it seems most likely that pattern-welding was largely decorational. It is quite possible that pattern-welding was thought to improve the properties of the swords, and it might be remembered that a smith with the skill to produce fine pattern-welding might be likely to produce a good quality sword anyway.

English or Continental origins

The next question to be considered is whether the sword blades were made in England or on the continent. According to tenth-century Arabian authors there were two Teutonic peoples producing pattern-welded swords: the Franks (Farang) and the East Scandinavians (Rus) (Liestøl 1951) while references to swords in Anglo-Saxon and

* in origin i.e. a technical process whose ornamental possibilities were soon realised, and in time was over the centuries only used ornamentally quite often (Ypey)

Scandinavian literature describe patterned blades and are discussed by Cramp (1957, 63–67), Liestøl (1951) Davidson (1962, 121–152) and Brady (1979, 90–110). Unfortunately the Anglo-Saxon and Scandinavian poets give us no direct information about where these swords were made. Cramp (p. 65) suggests that the reference in Beowulf to the manufacture of a sword by giants 'no doubt arose because the best pattern-welded swords were imports – the products of imported trade secrets'. This may have been the case, though as Brady observes (p. 121), supernatural smiths were part and parcel of Germanic legend and mythology both here and abroad, so we cannot be certain of the significance of the giant myth. Davidson (p. 34) sees no convincing reason why pattern-welded swords should not have been made in England, if only in a few workshops.

The question of origin is a difficult one to resolve since stylistically diagnostic features appear mainly on the hilt and other mounts which could and often were fitted in different centres from those where the blades were made (Davidson 1962). For example the sword from Lincoln, (1848, 10–21, 1) has a Continental blade and an Anglo-Saxon hilt. However in order to make some comparison with the patterns on the continental sword blades a brief survey of the technical literature was carried out. The quality of the illustrations varied, some only showed a small part of the blade and clearly the sample of surviving swords would not be representative (the same being true of the British Museum's collection). The survey therefore had its limitations, but the results are interesting, especially those from the cemetery at Schretzheim (Koch 1977). The 105 swords found there have been thoroughly investigated and are included in the table separately.

Table 7.6 Distribution of welded patterns on swords compared.

Types present	A	AS	B1	B2a	B2b	C1	C2(a+b)	Two pattern layers
Continent	12	1	2	1	1	3	1	8
British Museum	12	1	17	18	12	1	8	21
England (Gilmour)	3	2	7	4	1	1	2	
Schretzheim	17	2	12	5	–	3	4	8

(AS is a coincident straight and twist with two rods) Gilmour's results are published in Tylecote (1986).
Many of these continental patterns showed curving elements, which were the result of the surface being removed by grinding (Anstee 1961). The suffix X indicates this form

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Table 7.7 Distribution of curving patterns on swords.

	AX	B1X	B2bX	B2aX	C1X	C2X
England (Not British Museum*)	7	3	2	–	3	
Continent	10	17	3	5	2	2

* Only Crundale Down sword (1894.11–3.1). None were found by Gilmour.

The use of surface removal to vary the patterns is the most obvious difference in technique or pattern, the only example found in the British Museum was the lower end of the sword from Crundale Down (1894, 11–3, 1, mid seventh century). Several blades in the British Museum have close counterparts on the Continent, for example, Waterbeach with one side of the blades from Waal-bij-Nijmegen and Inversheim (Ypey 1982). Most inscribed swords appear to have been Frankish in origin, but some Anglo-Saxon copies may also have been made locally. The radiographic evidence suggests that the technique of grinding away the surface or slicing, as Liestøl suggested, were not much used in England, whereas they were frequently employed on the Continent to produce the curving patterns. Fullers (the so-called 'blood channel', a depression running down the blade on both sides) were thought to have been ground in and it may be inferred that they were made in this way on the Continent. However, in England, even where fullers are present, (predominantly on later blades), the absence of curving patterns shows that they were not ground but probably hammered. The results of Gilmour's metallographic studies of swords found in England were in agreement with this suggestion, showing hammered not ground fullers. This is strongly indicative that there was some kind of sword-making industry in England.

If Anglo-Saxon swords were made in England, what was the source of the iron, and where were they fabricated? In the area of Kent and Sussex there are two documentary pieces of evidence for iron working in the Anglo-Saxon period. A charter of AD 689 mentions an iron mine near Lyminge, Kent, while the Domesday book lists iron working near East Grinstead, Sussex. Crossley (1981) and Hill (1981) have used maps to show the distribution of Domesday and archaeological evidence of iron working. This is sparse, but an increasing number of sites are being discovered and no doubt other sites are yet to be discovered. Iron production debris can be difficult to date if other archaeological evidence is lacking. If forging took place at some distance from the smelting site (or imported iron had been used) it would not be easy to trace the forging site. Identification of such a site might have to rely on the discovery of traces such as the small spherical particles of slag which spray out around the anvil during forging; these have been found on an Iron Age site (Crew 1984). The only smelting or smithing remains from the early Saxon period at present appear to be slag bottoms of a north German type from Aylsham, Norfolk and Mucking, Essex and tap slag from Witton, Norfolk (Wilson and Hurst 1969, 1965), Shakenoak, Oxfordshire (Brodribb 1972), while Middle Saxon remains have been found in Northamptonshire (Williams, 1979; Addyman 1964); Ashdown forest (Tebbutt 1982) Southampton (Holdsworth 1980) and Wharram Percy (MacDonnell, personal communication). It is surprising that there is not more evidence for manufacture in the period from fifth to seventh centuries, as so many swords were being interred, many probably being made locally. Work at a royal smithying site at Ramsbsury, Wiltshire (Haslam 1980) has suggested that at least during the eighth and ninth centuries changes in technology occurred which point to the rediscovery of processes lost in England since the Roman Age. Site continuity would seem to have been extremely rare in this country.

On the Continent the picture is different. Although, according to Crossley (1981), it can be supposed that the same level of iron production was maintained on the Continent as during the Roman period, it seems likely that the departure of the Roman army reduced the demand somewhat in some areas. Unfortunately the evidence for post-Roman iron working, as in Britain, is sparse, except for Scandinavia, where there was a continuous increase in iron production which continued uninterrupted from the Iron Age to Medieval times (Martens 1983). Many extraction and working sites have been found, some with very large slag deposits. Large hoards of iron bars have also been found; for example 650 bars were found at Skedstand and bundles of iron bars from the migration period were found at Eketorp in Öland (Calissendorff 1979). Interestingly there is linguistic evidence for iron being sold in "garba" from the twelfth century onwards in England (Rogers 1865). This is a Latin trading term for a bundle or sheaf. Long thin round-sectioned bars forged together to make double tweezer-shaped bars were excavated at Helgö (Haglund 1978, 38). Could these have been intended for pattern-welding, perhaps even for export? Anstee (1961) tack-welded his rods together for ease of handling in his experiments. The Frisians traded in iron as is shown by finds from the port of Hedeby in Schleswig (Crossley 1981). These finds are from the Carolingian period (corresponding to the start of the Later Anglo-Saxon period in England) when there were edicts by the Holy Roman Emperors forbidding the export of weapons from the Carolingian Empire. In view of the large scale Scandinavian iron production (e.g. Martens 1983) it is conceivable that iron was imported thence into England, through north Germany or the Low Countries, but there is no evidence for this at present. No currency bars dating from the Anglo-Saxon period have been found in England.

On the present evidence, it must be concluded that while some swords were imported or else brought by their migrating owners, others were probably made in this country, from local iron or from iron transported over fairly short distances, rather than from imported bars and blooms. It is, however, not impossible that new archaeological evidence may be found for iron imports. Perhaps further excavations on urban sites may also reveal more iron production sites (like Southampton), or provide evidence for imports.

Socio-economic implications

The final question to be considered concerns whether changes in socio-economic patterns can be inferred from the swords and their deposition. To some extent, this topic awaits a detailed study of the swords and their fittings in relation to their find sites, but in the absence of such a study at present it is possible to draw some inferences from the data given above.

The results show that some changes occurred after the sixth century. All the swords datable to the seventh century were pattern-welded, but it would be a mistake to conclude that only pattern-welded swords were being made. A trend is detectable at this time towards isolated aristocratic graves and an increasing poverty can be seen in the other graves. Evidence from swords dated to the eighth century is sparse, as a result of changing burial practices, and none were examined in this project. In the ninth and tenth centuries the seax became a much more popular weapon than before among the Anglo-Saxons. In a recent paper Hodges (1985) suggested that, in the late first millenium, smiths were no longer few in number and attached to royal smithies like Ramsbury, Wiltshire (Haslam 1980), but increasingly were found in expanding towns, where there was a growing demand for domestic iron. Hodges argues that the weapons and tools of the smiths of this period which have been found indicate that cost consciousness was increasing a tendency towards standardisation. Hodges suggests that smiths could no longer afford to become engaged in making swords which took a month to produce. This may well have been true in England, although not necessarily true elsewhere; in Scandinavia for example, some smiths' graves are rich in the variety of metal working equipment. Probably the Rhineland

'Ulfberht' swords and most of the Anglo-Saxon seaxes required less time to construct as they were more simply made. The seaxes have only one cutting edge, are usually shorter in length, require less metal and probably had a handle which was simpler than the more complex sword hilt. Sometimes they were made from one piece of metal, but even when they were made from pattern-welded elements, the back edge and the blade were plain, and the whole would have been easier to weld together because it was shorter. Strengthening was given by the heavy back edge. As long as this was sound the weapon could be used. Perhaps the smiths felt more confident of producing a sound thicker sectioned blade than before. Evidence of the increasing popularity of the seax during the ninth to tenth centuries, tends to support Hodges' economic analysis of Anglo-Saxon iron production. The sudden increase in the number of swords surviving from towards the middle decades of the ninth century until the end of Late Saxon period can probably be attributed to two main factors. The first was the reintroduction to this country of burial practices by the pagan Vikings. Presumably the Late Saxon swords in the British Museum found in such graves had been obtained by trade or looting (i.e. Wensley, Sancton, Ardvonrig and Burneston).

* Another factor might be the custom of the sacrificial deposition of weapons in rivers (Wilson 1965, 50–1, Appendix A). The large number of swords and seaxes found in rivers, to which recent discoveries are still adding, is difficult to account for, although Alcock (1975, 345) points out that many battles were recorded as having been fought at river crossings. The sword from the Thames at Kew (reg. no. 1891, 9–5, 3) has only recently been reidentified from registration details and is added to the list while the sword from Lough Gur, Ireland (reg. no. 1864, 1–27, 30), might be included in the same category. A large number of the late seaxes too come from rivers which suggests that the sacrificial river deposits, if such they were, were made by both pagan Vikings and Christian Saxons.

6. Conclusions

A radiographic survey of the Anglo-Saxon and Viking swords and seaxes in the British Museum was carried out. Examination of the radiographs leads to the following conclusions:

1) Most British Museum swords have relatively simple patterns, compared with Continental swords and even compared with other English swords examined elsewhere. The patterns are based on two or three twisted rods or rod composites, with some straight sections. Eight groups showing variations of these factors have been distinguished.

2) A few swords have patterns which do not fit into these categories; two of these have Continental counterparts (Hurbuck with an Anglo-Saxon sword from Borgstedt, Schleswig-Holstein and Waterbeach with Inversheim and Waal-bij-Nijmegen). The two-band continuous twist pattern was popular both in England and on the Continent.

3) Many Continental patterns have curving patterns, resulting from grinding away the surface. In the British Museum such a pattern is only present on part of one sword, from Crundale Down. It seems likely that most of the British Museum swords were finished by hammering rather than grinding and are therefore probably the products of a local technological tradition which has developed differently from that on the Continent.

* see BROB 12–13 (1962–3) 153 – in battle swords thrown into river by defeated soldiers to prevent capture of their weapons

Blair ('A/S Oxon' 1994) – swords could have been deposited in rivers at peace-making or oath-taking ceremonies

4) Socio-economic changes were reflected by the decreasing number of swords which were interred during the seventh century. The increased proportion of pattern-welded swords indicated that only the wealthier, more important men were buried with their swords.

Three more general conclusions may also be mentioned.

5) At present there is insufficient evidence to determine whether pattern-welding was primarily for strengthening or decoration, but it is clear that the latter was very important.

6) The survey further underlines the richness of society in Kent.

7) The chronology and distribution of find sites reflects the changes in religious practices, with the disappearance of swords in Anglo-Saxon graves after the late seventh century, and the appearance of the river sacrifices, mainly in the ninth–tenth centuries, made, it would seem, by both Anglo-Saxons and Vikings.

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FMA St. 18 (1984) 226 - deposition also of gold rings, bronze bowls, etc. in rivers (cf. BM Seine ring), link with water spirits, to appease demons, lasts into middle ages.
Cf. also doge of Venice annually threw gold ring into Adriatic to symbolise wedding with the sea

Table 7.1

T Inscription
O No pattern
I Inlay, non ferrous metal
P Pattern, but not clear enough to be categorised or not in one of the categories.
S Seax

* See section on inscriptions

Registration	Culture	Date AD	Location of find	Type, Features
AL 116/775	AS	9	Thames, Westminster	B1 2 layers
Oliver's Battery (on loan)	AS	7	Hampshire	IS
Lyle 236 (Not in BM)	AS	10	Thames, Westminster	T
Yorkshire Museum	AS	6–7	Acklam	P
Tr 169		9	?Nottingham *	P
Tr 173	AS	9–10	No provenance	O
Tr 174	V	E10	Nottingham	T
OA 321	AS	No Details		O
OA 324	AS	9–10	No provenance	O grooves
OA 6609	AS	5–7	Gt Chesterford	O
OA 6610	AS	5–7	Barnet, Herts	C2a
OA 6568	AS	5–7	?Kent	O
557	AS	5–6	Mucking, Essex	O
618	AS	5–6	Mucking, Essex	O 3 plain
682	AS	5–6	Mucking, Essex	O
776	AS	5–6	Mucking, Essex	O
769	AS	5–6	Mucking, Essex	O
951–70	AS	E6	Faversham, Kent	P
952–70	AS	E6	Faversham, Kent	B2b
953–70	AS	6	Faversham, Kent	B1 2 layers
954–70	AS	c.525–600	Faversham, Kent	B2a 2 layers
956–70	AS	5–7	Faversham, Kent	B2a + B2b 2layers
957–70	AS	6	Faversham, Kent	B2a + B2b 2 layers
958–70	AS	5–7	Faversham, Kent	O
1839 10–29 144b	AS	(6)–7	Chartham Down, Kent	B1
1839 10–29 144a	AS	(6)-7	Chartham Down, Kent	A
1848 7–27 1	AS	L5	Battle Edge, Burford, Oxford	B2a
1848 10–21 1	AS	10	Lincoln	T
1850 2–7 1	AS	9–10	Thames	I
1853 4–12 89	AS	6–7	Barham Downs, Kent	B1
1853 4–12 90	AS	6–7	Barham Downs, Kent	B1 (probably fragments of same sword as 1853 4–12 89
1854 11–7 12	AS	L9–10	Norwich	C1
1855 10–18 1	AS	5–6	Ashdown, Berks	O
1856 7–1 1404	V	10–11	Thames, Temple	T

* shown in Deposit Register (Loan 22) as going with pommel Tr. 175, also from a Petersen Z sword, but no evidence known to otherwise associate them unless Royal Armouries have further details in their documentation. Pommel is drawn in Arch J. 8 (1851) 425 among Nottingham finds, but not this blade + l. guard

Registration	Culture	Date AD	Location of find	Type, Features
1856 7–1 1405	AS	L9	London	A
1856 7–1 1408	AS	9–10	London	PS
1856 7–1 1409	AS	9–10	London	OS grooved
1856 7–1 1410	AS	9–10	London	OS grooved
1856 7–1 1411	AS	9–10	London	OS grooved
1856 7–1 1412	AS	9–10	Finch Lane, London	OS grooved with plaited Cu/Au
1856 7–1 1413	AS	9–10	Honey Lane, London	IS inlaid line of alternating bronze + copper wire set in herringbone pattern
1857 6–23 1	AS	L9	Battersea	IS non-ferrous twisted wire inlay runic inscription
1857 6–23 2	–	9–10	Battersea	IS bands
1859 1–22 12	AS	9–10	Thames, London	IS plaited Cu/Au
1862 7–19 5	AS	6–7	Milton Field, Berks	OS
1862 7–19 6	AS	L6–7	Long Wittenham, Oxon	OS grooved
1864 1–27 3	V	10	Loch Gur, Co. Limerick, Ireland	I
1867 7–29 150	AS	c.500	Chessell Down IOW	B2a
1867 7–29 152	AS	6	Chessell Down IOW gr.84	O
1868 9–4 24	AS	9–10	Thames, London	OS grooved
1869 3–15 1	A	5–6	Waterbeach, Cambs	P
1869 10–11 13	AS	E6	Chessell Down IOW gr.26	B1 + straights on edges
1869 10–11 14	AS	L5–6	Chessell Down IOW	O
1869 10–11 15	AS	L5–6	Chessell Down IOW	O
1869 10–11 16	AS	L5–6	Chessell Down IOW	B2B
1869 10–11 17	AS	L5–6	Chessell Down IOW	B1
1869 10–11 18	AS	L5–6	Chessell Down IOW	O
1869 10–11 55	AS	L5–6	Chessell Down IOW	O
1873 6–2 104	AS	7	Tissington, Derbys	B2b
1875 3–10 40	AS	6	Long Wittenham, Oxon	C2a
1875 4–3 169	AS	L9	Burneston, N Yorks	T
1876 2–12 30	AS	L5–6	Lakenheath Fen, Suffolk	O
1876 2–12 46	AS	L5–6	Barrington, Cambs	O
1879 12–9 2078	AS	7	Lowick, Northumberland	SO
1850 5–21 1	AS	6	Longbridge, Warwicks	B1
1880 8–9 1	AS	L5–6	Barrington, Cambs	O
1881 6–23 1	AS	9–10	Sittingbourne, Kent	IS Cu or Au letters, strip and plaits
1883 7–26 1	AS	L9	Santon, Norfolk	O Viking grave
1883 12–12 1	AS	9–10	Little Bealings, Suffolk	PS grooved
1883 12–13 612	AS	6	Sittingbourne, Kent	B2a
1883 12–13 613	AS	6	Sittingbourne, Kent	O
1883 12–13 614	AS	6	Sittingbourne, Kent	O

Registration	Culture	Date AD	Location of find	Type, Features
1883 12–13 621	AS	6	Sittingbourne, Kent	B2b
1883 12–13 622	AS	6	Sittingbourne, Kent	O
1883 12–13 646	AS	6	Faversham, Kent	C2a
1883 12–13 647	AS	6	Faversham, kent	O
1883 12–14 4	AS	E7	Taplow, Bucks	C2a
1847 2–9 1	V	10–E11	Temple London	B2b
1888 7–19 57	AS	5–7	unprovenanced	B2a two layers
1890 9–2 1	AS	6?	Lyminge, Kent	B1 + B2b two layers
1891 3–23 1	AS	L5–6	E Shefford, Berks	O
1891 6–24 75	AS	6	Kempston, Beds	O No pattern
1891 6–24 78	AS	6	Kempston, Beds	B1
1891 6–24 79	AS	L5–6	Kempston, Beds	P
1891 6–24 80	AS	5–7	Kempston, Beds	P
1891 6–24 103	AS	6–7	Kempston, Beds	OS
1891 6–24 131	AS	9–10	Kempston, Beds	O
1891 9–5 3	V	10	Kew, Thames	T
1894 8–3 87	AS	L5–6	?Strood, Kent	C2a
1894 11–3 1	AS	M7	Crundale Down, Kent	B2a 2 layers ground away cruciform pattern at tip
1894 12–16 4	AS	E7	Broomfield, Essex	B2a 2 layers
1895 3–13 10	AS	6	Croydon	O
1895 6–13 22	AS	9	Ardvonrig, Barra	A 2 opposed layers
1896 5–22 5	AS	6–7	Thames	O
1902 7–22 171	AS	L5–6	Droxford, Hants	A
1902 7–22 172	AS	L5–6	Droxford, Hants	O
1902 7–22 173	AS	L5–6	Droxford, Hants	O
1902 7–22 174	AS	L5–6	Droxford, Hants	O
1902 7–22 175	AS	L5–6	Droxford, Hants	P
1902 7–22 176	AS	L5–6	Droxford, Hants	O
1902 12–16 2	AS	E6	Windmill Hill, Bucks	B1
1906 6–12 1	V	9–10	Farndon, Notts	P
1912 7–23 1	AS	L9	Hurbuck, Durham	B1 2 layers
1912 7–23 2	AS	9–10	Hurbuck, Durham	PS whorl patt. inlayed Cu/Au plait
1912 12–20 2	AS	L7	Twickenham, Surrey	B1
1913 7–17 1	AS	7	Barlaston, Staffs	F
1915 5–3 2	AS	L5–6	Herringswell, Suffolk	B2a
1915 5–4 1	V	L9–E10	Edmonton, Middx	T
1915 12–8 353	AS	5–6	Astwick, Beds	B2b
1918 7–8 13	AS	L5–6	Howletts, Kent	O
1929 2–6 1	V	10–11	Windsor, Berks	P
1936 5–11 54	AS	L5–E6	Howletts, Kent gr.16	B2a 2 layers
1936 5–11 75	AS	6	Howletts, Kent gr.19	C2b
1936 5–11 76	AS	E6	Howletts, Kent gr.20	P

Registration	Culture	Date AD	Location of find	Type, Features
1936 5-11 99	AS	6	Howletts, Kent gr.25	B2a
1936 5-11 132	AS	6	Howletts, Kent gr.36	0
1936 5-11 164	AS	5-6	Howletts, Kent	A(S)?
1936 5-11 166	AS	5-6	Howletts, Kent	B1
1939 10-10 95, 19-29	AS	E7	Sutton Hoo, Suffolk	C2b 2 layers
1963 11-8 124	AS	L5-E6	Dover, Kent gr.22	B2a
1963 11-8 128	AS	E7	Dover, Kent gr.27	B2b
1963 11-8 174	AS	E7	Dover, Kent gr.33	B1
1963 11-8 281	AS	6-E7	Dover, Kent gr.41	B2a
1963 11-8 340	AS	L6-E7	Dover, Kent gr.56	B2a
1963 11-8 416	AS	E7	Dover, Kent gr.71	A
1963 11-8 469	AS	6	Dover, Kent gr.91	B2b
1963 11-8 483	AS	6	Dover, Kent gr.93	A
1963 11-8 493	AS	6-7	Dover, Kent gr.94B	B2a
1963 11-8 502	AS	E7	Dover, Kent gr.96A	A
1963 11-8 509	AS	E7	Dover, Kent gr.96B	A
1963 11-8 511	AS	6	Dover, Kent gr.98	F2b
1963 11-8 603	AS	E7	Dover, Kent gr.131	B2b
1963 11-8 751	AS	525-600	Dover, Kent gr.90	B2a
1963 11-8 782	AS	6-7	Dover, Kent	A
1963 11-8 783	AS	6-7	Dover, Kent	B2a
1964 7-2 381	AS	6	Gt Chesterford, Essex	B1
1965 7-3 1	AS	L9	Wensley, Yorks (old)	C2a

References

Addyman, P.V. 1964: A Dark Age Settlement at Maxey, Northamptonshire, *Medieval Archaeology* 8, 20–73.

Alcock, L. 1975: *Arthur's Britain*, 345.

Anon 1851: Antiquities and Works of Art Exhibited, *Archaeological Journal*, 8.

Anstee, W.J. and Biek, L. 1961: A Study in Pattern-Welding, *Medieval Archaeology* 5, 71–93.

Anteins, A.K. 1966: Im Ostbaltikum gefundene Schwerter mit damaszierten Klingen II, *Waffen und Kostumkunde*, 111–126.

Anteins, A.K. 1968: Structure and Manufacturing Techniques of Pattern Welded Objects found in the Baltic states, *Journal of the Iron and Steel Institution*, June, 563–570.

Belaiew, N.T. 1918: Damascus Steel, *Journal of the Iron and Steel Institution* 97, 417–574.

Belaiew, N.T. 1921: Damascene Steel part II *Journal of the Iron and Steel Institute* 104, 181–186.

Brady, C. 1979: Weapons in *Beowulf*: an analysis of the nominal compounds and an evaluation of the poet's use of them, *Anglo-Saxon England* 8, 79–141.

Brodribb, A. 1972: *Excavations at Shakenoak Farm, Wilcote, Oxon.* Pt. 3.

Brown, P.D.C. & O'Leary, T. (forthcoming): The Bath 'Ulfberht' sword, in B. Cunliffe's report (forthcoming) on the Bath excavations.

Bruce-Mitford, R.L.S. 1953: Some recent results of the application of laboratory techniques to antiquities of the Anglo-Saxon period in Britain, *Congrès International des Sciences Préhistoriques et Protohistoriques.* Actes de la IIIe. Session, Zurich 1950, 321–323.

Bruce-Mitford, R.L.S 1978: *The Sutton Hoo Ship Burial* Vol. 2 (BMP).

Calissendorff, K, 1979: Linguistic Evidence for Early Iron Production, in *Iron and Man in Prehistoric Sweden* ed. Helen Clark (Jernkontoret).

Cleere, H. 1983: The Organisation of the Iron Industry in the Western Roman Provinces in the Early Empire with Special Reference to Britain, *Offa* 40, 103–114.

Cramp, R. 1957: *Beowulf* and archaeology, *Medieval Archaeology* 1, 57–77.

Crew, Peter 1984: Bryn y Castell, Ffestiniog. A Late Prehistoric Working Centre, *Symposium of the Comité pour La Sidérugie Ancienne* (Belfast).

Crossley, D.W. 1981: Medieval Iron Smelting in *Medieval Industry* ed. D.W. Crossley (CBA Research Report No. 40).

Davidson, H.R.E. 1962: *The Sword in Anglo-Saxon England. Its Archaeology and Literature* (Oxford).

East, K., Larkin P. and Winsor P. 1985: The Chertsey Ulfberht sword, *Surrey Archaeological Collections* 76.

Emmerling, J. 1972: Technologische Untersuchungen an Eisernen Bodenfunden, *Alt-Thüringen.*

Emmerling, J. 1978: Technologische Untersuchungen an Kaiserzeitlichen Schwertern aus Buchhain, *Alt-Thüringen* 15, 92–102.

Emmerling, J. 1979: Zur Technologie Zweier Schwerter und einer Lanzenspitze aus Wolkow, *Alt-Thüringen* 16, 120–126.

Evans, A.C. 1978: In *The Sutton Hoo Ship Burial* Vol. 2, ed. R. Bruce-Mitford (BMP).

Evison, V.I. 1967: A sword from the Thames at Wallingford Bridge, *Antiquaries Journal* 124, 160–189. Arch.

Evison, V.I. 1987: Dover: The Buckland Cemetery.

France-Lanord, A. 1949: La Fabrication des épées damassées aux époques mérovingiennes et carolingiennes, *Le Pays Gaumais* 10, 1, 2, 3.

France-Lanord, A. 1952: Les techniques de la metallurgie du fer de la préhistoire au temps des Grandes Invasions, *Revue de Metallurgie* 49, 411–422.

Goodway, M. 1987: Phosphorus in Antique Iron Music Wire, *Science* 236, 927–932

Haglund, K. 1978: Rod-shaped and Scythe-shaped currency bars, *Excavations at Helgö*,V: 1, 38–45.

Haslam, Jeremy 1980: A Middle Saxon iron smelting site at Ramsbury Wiltshire, *Medieval Archaeology* 24, 1–68.

Hill, D. 1981: *Atlas of Anglo-Saxon England* (Oxford).

Hodges, R. 1985: Beginnings of the Medieval Iron Industry in Western Europe in *Medieval Iron in Society* (Symposium Stockholm).

Holdsworth, P. 1980: *Excavations at Melbourne Street, Southampton 1971–76* (Southampton Archaeological Research Committee Report, CBA).

Kirpichnikov, A.N. 1966: Drevnerusskoye oruzhiye (vyp.I). Mechi i Sabli, IX–XIII vv. *Arkheologiya SSR* (Svod Arkheologicheskikh Istochnikov), E1–36.

Kirpichnikov, A.N. 1969: Russiske-Skandinaviske forbindelser i IX–XI århundrede, illustreret ved våbenfund, *Kuml*, 1969 (Årbog for Jysk Arkaeologisk Selskab) 165–189 (Copenhagen).

Koch, U. 1977: *Das Reihengräberfeld bei Schretzheim* (Germanische Denkmäler der Völkerwanderungszeit, Serie A, 13. Berlin).

Lang, J.R.S. 1984: The Craft of the Blacksmith. *Symposium of the Comité pour la Sidérurgie Ancienne* (Belfast).

Lang, J.R.S. and Price, J. 1976: Iron tubes from a Late Roman Glass-making site at Merida, *Journal of Archaeological Science* 2, 296–298

Leppäaho, J. 1964: *Späteisenzeitliche Waffen aus Finnland. Schwertinschriften und Waffenverzierungen des 9–12. Jahrhunderts.* (Suomen Muinaismuistoyhdistyksen Aikakauskirja/Finska Fornminnesforeningens Tidskrift 61. Helsinki).

Liestøl, Aslak 1951: Blodrefill og Mål, *Viking, Tidsskrift for norrøn arkeologi* 15 (Oslo).

Lorange, A.L. 1889: *Den Yngre Jernalders Svaerd. Et Bidrag til Vikingetidens Historie og Teknologi* (Bergen Museum).

Martens, H. Irmelin 1983: The Norwegian Bloomery Furnaces and their Relation to the European Finds, *Offa* 40, 119–124.

Maryon, H. 1948: A Sword of the Nydam type from Ely Fields Farm, near Ely. *Journal of the Cambridge Antiquarian Society* 41, 73–76.

Maryon, H. 1950: A sword of the Viking period from the River Witham, *Antiquaries Journal* 30, 175–9.

Maryon, H. 1960: Pattern Welding and Damascening of Sword Blades *Studies in Conservation* 5, 25–36, 52–59.

McGrath, J.N. 1973: A report on the Metallurgical Examination of 5 fragmentary Early Iron Age sword blades from Llyn Cerrig Bach, *Journal of Arms and Armour Soc.*, 71.

Menghin, Wilfried 1974: Ein Langobardisches Kriegergrab in Germanischen National Museum Nürnberg, *Archäologisches Korrespondenzblatt* 4, 251–256.

Menghin, Wilfried 1983: *Das Schwert im Frühen Mittelalter* (Nürnberg).

Modin, Sten: unpublished report.

Müller-Wille, M. 1970: Ein neues ULFBERHT-Schwert aus Hamburg, *Offa* 27, 65–88.

Müller-Wille, M. 1977: Krieger und Reiter im Spiegel früh-und hochmittelalterlicher Funde Schleswig-Holsteins, *Offa* 34, 40–74 (Neumünster).

Müller-Wille, M. 1982: Zwei Karolingische Schwerter aus Mittelnorwegen, in H-J. Hässler *et al.* (eds), *Studien zur Sachsenforschung* 3, 101–154 (Hildesheim).

Neumann, B. 1927–8: Romanische Damastahl, *Archiv für das Eisenhüttenwesen* (Düsseldorf).

Oakeshott, R.E. 1951: An "Ingelri" sword in the British Museum, *Antiquaries Journal* 31, 69–71.

Oakeshott, R.E. 1960: *The Archaeology of Weapons* (London).

Page, R.A. 1964: The inscriptions, Appendix A in Wilson (1964), 67–90.

Panseri, C. 1963: Damascus steel in Legend and Reality, *Gladius* 4, 5–66.

Petersen, J. 1919: De Norske Vikingesverd. En typologisk-Kronologisk studie over vikingetidens vaaben, *Skrifter utgit av Videnskaps-selskapet i Kristiania.* II.Hist.-Fil.Klasse 1919. No. 1.

Piaskowski, J. 1961: Metallographic investigations of ancient iron objects from the territory between the Oder and the basin of the Vistula River *JISI*, July 1961.

Pleiner, Radomir 1969: Eisenschmiede im frühmittelalterlichen Zentral Europa, *Archäologischer Anzeiger*, Heft I, 79–92.

Read, C.H. 1915: A Viking sword found in the Lea near Edmonton, *Proceedings of the Society of Antiquaries of London*, 2nd ser. 27 (1914–15), 215–217.

Rogers, J.E.T. 1865–6: *A History of Agriculture and Prices in England from 1259*, 2 Vols. (Oxford).

Rollason, E.C. 1978: Metallurgy for Engineers.

Rosenqvist, Anne 1967–68: Sverd med Klinger ornert med figurer i kopperlegeringer fra eldre jernalder, i Universitetets Oldsaksamling Oslo, *Unversitetets Oldsaksamling Årbok* 1967–1968, 143–200.

Salin, E. 1957: *La Civilisation Mérovingienne* (iii).

Schultz, E. H. and Pleiner, R. 1965: Untersuchungen an Klingen eisener La Tène Schwerter, *Technische Beiträge zur Archäologie* 2, 38–50.

Schürmann, Eberlard 1959: Untersuchungen an Nydam Schwertern, *Archiv für das Eisenhüttenwesen* 30.3, 121–120.

Shetelig, H. 1940: *Viking Antiquities in Great Britain and Ireland. Pt.IV. Viking Antiquities in England* (Oslo).

Smith, C.S. 1957: A Metallographic Examination of Some Japanese Sword blades, Symposeum *La Tecnica di Fabbricazione delle Lame di Acciaio Presso gli Antichi*, ed. C. Panseri, Quaderno II, 41–64.

Smith, C.S. 1960: *A History of Metallography* (Univ. Chicago Press).

Stalsberg, A. 1981: Zu Datierungen der frühen wikingerzeitlichen Funde Skandinavischer Herkunft in der alten Rus, *Les Pays du Nord et Byzance (Scandinavie et Byzance). Actes du colloque d'Upsal 20–22 avril 1979.* (Acta Universitatis Upsaliensis, Figura, Nov. ser. 19), 53–62.

Tebbutt, C.F. 1982: A Middle-Saxon Iron Smelting site at Millbrook, Ashdown Forest, Sussex, *Sussex Archaeological Collections* 120, 19–35.

Tylecote, R.F. 1962: *Metallurgy in Archaeology.*

Tylecote, R.F. 1976: *A History of Metallurgy* (The Metals Society).

Tylecote, R.F. and Gilmour, B. 1986: *The Metallography of Early Ferrous Edge Tools and Edged Weapons* (BAR 155, Oxford).

Wadsworth, J. and Sherby, Oley D. 1979: On the Bulat (Damascus Steels) *Bull. Metals Museum Japan* 4 Sept, 7–23.

Webster, G. 1982: in *The Archaeology of Canterbury vol I – Excavations at Canterbury Castle* – P. Bennett, S. Frere and S. Torr, (Kent Archaeological Society) 184–190.
Wegeli, R. 1902–5: Inschriften auf mittelalterlichen Schwertklingen, *Zeitschrift für Historische Waffenkunde* 3, 177–183 and 218–225 (Dresden).
Williams, J.H. 1979: *St Peter's Street Northampton. Excavations 1973–6.*
Wilson, D.M. 1964: *Anglo-Saxon Ornamental Metalwork 700–1100 in the British Museum* (British Museum, London).
Wilson, D.M. 1965: Some neglected late Anglo-Saxon swords, *Medieval Archaeology* 9, 32–54.
Wilson, D.M. 1969: Medieval Britain in 1968, *Medieval Archaeology* 13, 230–87.
Wilson, D.M. and Hurst D.G 1965: Medieval Britain in 1964, *Medieval Archaeology* 9, 170–220.
Yater, W.M 1983–4: The Legendary Steel of Damascus, *The Anvil's Ring*, 11, 4 pp. 2–17.
Ypey, J. 1960–1: Een aantal vroeg-middeleeuwse zwaarden uit Nederlandse musea, *Berichten van de Rijksdienst voor het Oudheidkundig Bodemonderzoek* 10–11, 368–394.
Ypey, J. 1973: In *Reallexikon der Germanischen Altertumskunde* (ed. J. Hoops, Berlin).
Ypey, J. 1982: Europäische Waffen mit Damaszierung, *Archäologisches Korrespondenzblatt* 12, 381–388.
Ypey, J. 1983: Rekonstruktionsversuch der Schwertklinge von Sutton Hoo. *Archäologisches Korrespondenzblatt* 13, 495–498.
Ypey, J. 1984: Einige wikingerzeitliche Schwerter aus den Niederlanden, *Offa* 41, 213–225.