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TESTING A CLASSIFICATION SYSTEM

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ABSTRACT

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A classification system is presented on the basis of morphological criteria for Iron Age arrow-heads made from iron. The attributes discussed are: (1) the number of edges, (2) the shape of the shafting part, (3) the outline of the blade, (4) the cross-section of the blade, and (5) the location of the blade's greatest width.

The system is tested on arrow-heads from Hordaland, western Norway. Thirty types were found. Two-edged arrow-heads predominate. The multi-edged arrow-heads largely belong to the Migration Period, while most of the two-edged arrow-heads are from the Viking Period.

Most of the Migration Period arrow-heads come from coastal districts and were probably used for warfare. However, the Viking Period arrow-heads, primarily seem to have been used for hunting. These are mostly found in graves in fjord districts and as stray finds in the moutains.

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CONTENTS

1.0 INTRODUCTION

Iron arrow-heads are found in a great number of Norwegian graves from the Iron Age; from the Migration Period (AD 400 - 600) to the Viking Period (AD 800 - 1000). Stray finds from the mountains and other hunting areas are known as well. Before the Migration Period, arrow-heads made of bone were used (Hougen 1932, Farbregd 1972). Iron arrow-heads were still used during the Middle Ages. However, the blacksmiths of this period, did not work under the same demands for standardized shapes and sizes as did the Iron Age blacksmiths.

The arrow-head consists of a limited number of attributes but the combinations of these attributes are numerous, making systematic classification and study of these artifacts very difficult. Jan Petersen (1919) made an extensive study of Viking Period weapons in Norway. In this work, all kind of weapons were grouped into types with the exception of arrow-heads. These were superfically discussed by the investigator who was aware of the serious difficulties in bringing them into order (op.cit. p. 48). Therefore the more than 100 years old atlas of Norwegian artifacts made by Oluf Rygh (1885) is still the basic reference book for arrow-head classification. Other frequently used references are "Vestlandske graver fra jernalderen" by Haakon Shetelig (1912) and "Jaktfunn fra dalbygdenes folkevandringstid" by Bjørn Hougen (1932).

Only a few Scandinavian archaeologists have dealt with this group of artifacts. Per Fett (1940a, 1940b) discussed arrow-heads from the Migration Period in Norway, while Erik Wegraeus discussed those from the Viking Period in Sweden. Other type series have been presented by Inga Serning (1966) and Aslak Liestøl (1968). A local study has been made by Oddmunn Farbregd (1972).

Ten years ago I presented a classification system which should simplify the classification and study of Iron Age arrrow-heads (Sognnes 1977). This system has partly been used in a study of mountain finds from Gudbrandsdalen, eastern Norway (Hofset 1981). The great number of Iron Age arrowheads and their many attribute combinations make them particularly suitable for computer analysis. However, when the classification system was made I did not have access to computers or relevant programs. Therefore I was only able to present the system as such. My returning to this subject ten years later is due to available computèrs at the University of Trondheim. Because this classification system was already established and a preliminary study had been made (Sognnes 1977), the Hordaland arrow-heads were chosen for the testing of computerised archaeological statistics at the University Museum in Trondheim in 1983. In this work Cand. philol. Eirik Lien was of inestimable help.

2.0 THE CLASSIFICATION SYSTEM

The system is based on morphological attributes. The terminology used is presented on Fig. 1. The arrow-head has two main parts, the **blade** and the shafting part. The shafting part may be a **tang** or a **socket**. The transition from the blade to the shafting part is generally smoothly curved. The part of the blade without cutting **edges** is called the **blade root** or **run**. The **point** is the foremost sharp part of the blade. The edges often end in **edge corners**. The tang may have a ledge, which divides it into a **tang nail** and a **tang neck**. Similarly socketed arrow-heads may have a **socket neck** (cf. Farbregd 1972, p. 14).

Both the blade and the shafting part should be taken into consideration when establishing a classification system. The most important attributes on the blade are the point and the cutting edges. Most arrow-heads have two edges, but many have three or four edges. Awl-like arrow-heads without edges are relatively frequent, and some one-edged arrow-heads also occur. Primarily the system should separate arrow-heads with different numbers of edges. I have chosen to start with the greatest number of edges and end with one edge. The circular, awl-like arrow-heads do not seem to fit into such a scheme. However, if we continuously increase the number of edges, the cross section will become a circle. Therefore, the arrow-heads with circular cross section should be considered as having an infinite number of edges.

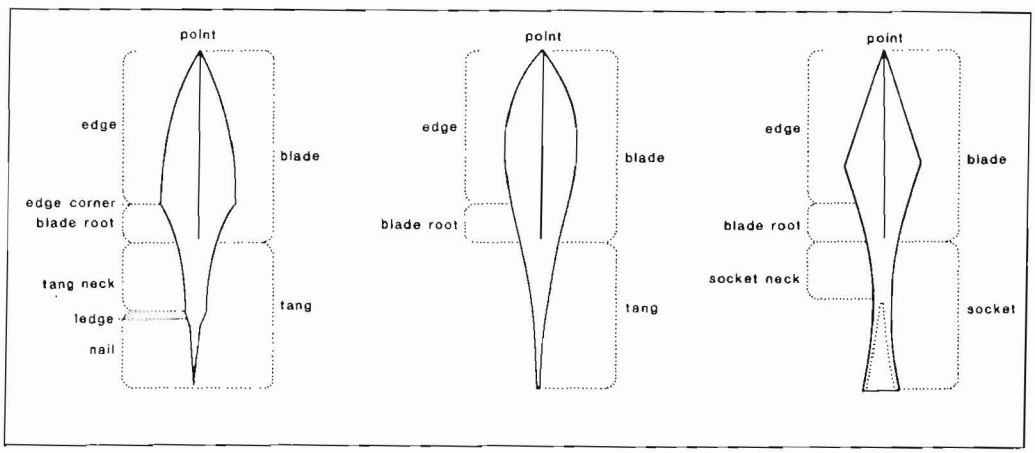

Fig. 1. Terminology used for Iron Age arrow-heads (drawings after Farbregd 1972).

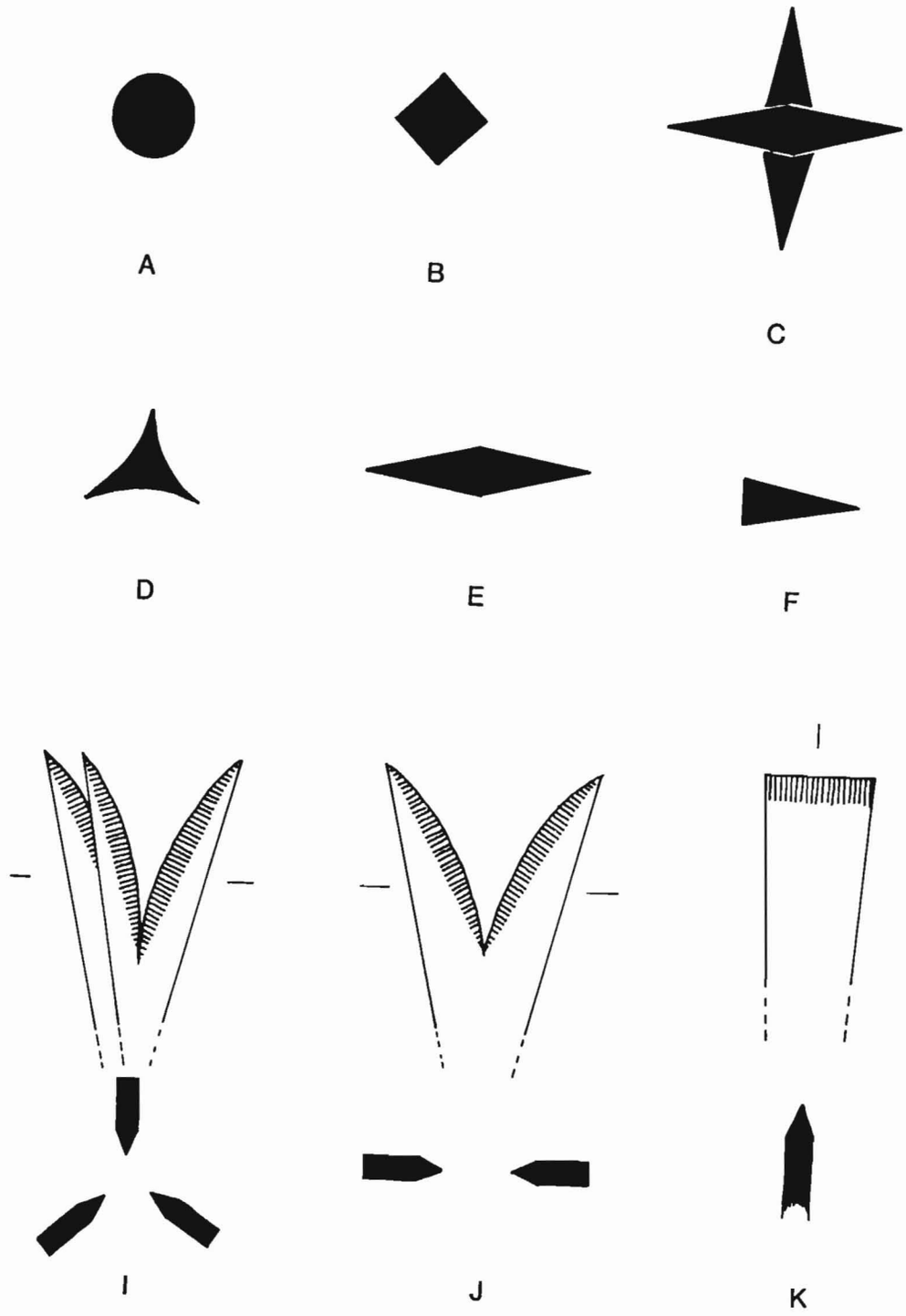

Fig. 2. Edges found on arrow-heads from Norway.

Normally arrow-heads have side edges, but other edges are found particularly among the one-edged. Most of these have a transverse or oblique edge on top of the blade. The one-edged arrow-heads should therefore be divided into two main groups, one with a side edge and one with a transversal or oblique edge. Most of the two-edged arrow-heads have side-edges, but some have edges facing each other like forked interior edges in the upper part of the blade. Similar three-edged arrowheads are known. Even the four-edged should be divided into two groups. One group has edges along the sides, but a second group has two two-edged parts placed perpendicular to each other, making four cutting edges. Each kind of edge is named by a capital letter from A to K (Fig. 2).

A: circular arrow-heads
B: arrow-heads with four edges running along the entire length of the blade
C: arrow-heads with four edges where the blade is made of two two-edged parts placed perpendicular to each other
D: arrow-heads with three side edges
E: arrow-heads with two side edges
F: arrow-heads with one side edge

All arrow-heads belonging to these groups have side edges. Most of the arrow-heads with transversal or internal edges have two edges, but at least one three-edged is known. Theoretically four-edged (**H**) and circular (**G**) arrow-heads of these kinds may also be found.

I: arrow-heads with three internal edges
J: arrow-heads with two internal edges
K: arrow-heads with one transversal or oblique edge

The shafting part is another important attribute. This may be a socket or a tang. The tangs are made in different ways. Some of them are characteristic for different periods. The tang may be flat, square or pointed, with or without a ledge. However, the shafting part is often broken off and missing, or it is so strongly corroded that it can not be classified. The different kinds of sockets and tangs are named by small letters from a to g (Fig. 3).

a: socket
b: flat tang
c: pointed tang without ledge
d: pointed tang with ledge. The tang has a circular or diamond-shaped cross section.
e: tangs with a thickening at the transition between the neck and the nail
f: square tang without a ledge. The tang has a quadratic or rectangular cross section.

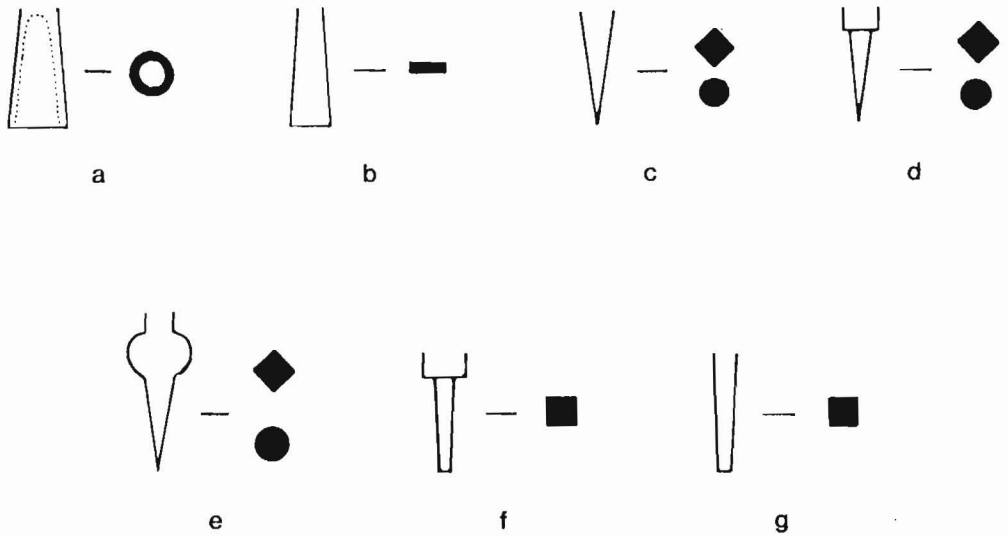

Fig. 3. Shafting parts found on arrow-heads from Hordaland.

g: square tang with a ledge, the nail having quadratic or rectangular cross section.

In the first edition of the system (Sognnes 1977), I did not separate the groups d and e, and in the test analysis presented here these two groups are still treated as one (d).

However, the system is still incomplete, particularly for the two-edged arrow-heads, but also for the three- and four-edged. The side-lines, or the outline, give a good expression of the shape of the blade. Normally, the outline is identical with the edges, but for arrow-heads with transversal or internal edges they are not. Most of the blades are symmetrical; the left and right hand parts have identical outlines (Fig. 4).

I : the edges are parallel
II : the edges are straight, converging toward the point
III : the blade has evenly curved sidelines, which normally give the blade a biconvex shape
IV : the blade has edge corners
V : the blade is diamond-shaped
VI : the blade is triangular with straight edges and base
VII : the blade is triangular with curved edges and base
VIII : the blade has barbs
IX : the blade has an upper narrow part and a lower wide part

The section of the blade varies in two-edged arrow-heads. This is also taken into consideration (Fig. 5A).

1: the blade is flat
2: the blade has a diamond-shaped cross-section
3: the blade has a diamond-shaped cross-section with rib along the central line
4: the blade is hammered flat in the middle
5: the central part of the blade has been hammered further down, making a shallow depression
6: the blade has a shallow depression on each side of a central line

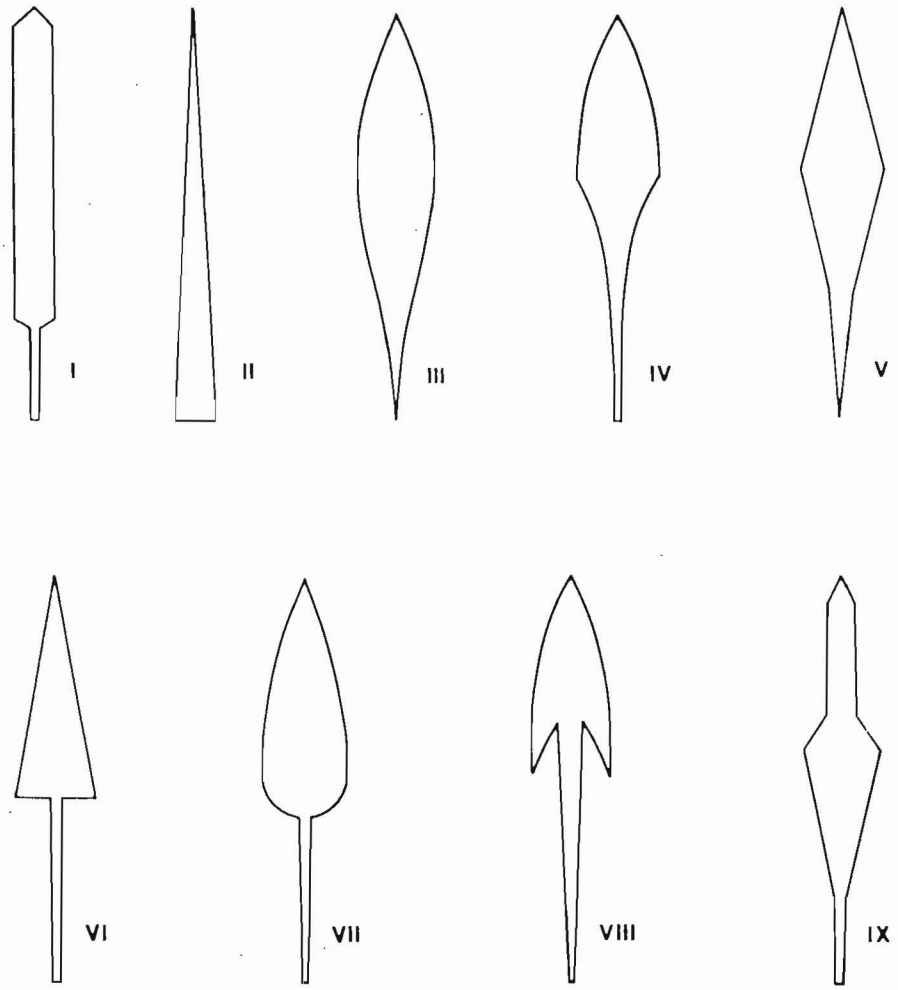

Fig. 4. Blade outlines found on arrow-heads from Hordland.

Here, I do not distinguish between narrow and wide blades with the same main shape. However, I have taken into consideration the location of the blade's greatest width (Fig. 5B).

01: the blade is widest near the point
02: the blade is widest in the middle
03: the blade is widest near the shafting part

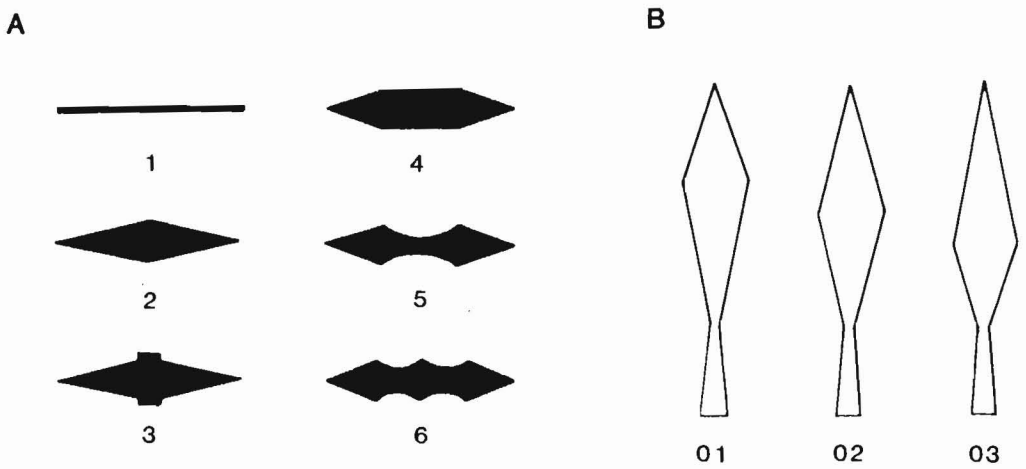

Fig. 5. A: Cross-section of the blade. B: Location of the blade's greatest width.

Normally, there should not be any problems with classifying this attribute. However, one sometimes comes across arrow-heads where it is difficult to decide in which part of the blade the greatest width is located. A definition is therefore necessary. Arrow-heads having their greatest width in the upper 2/5 belong to group 01, those having their greatest width in the lower 2/5 to group 03, and those that are widest in the central 1/5 to group 02.

Each group of artifacts have been given separate labels. Capital letters (A-K) are used for the number and kind of edges, small letters (a-g) for how the shafting part is shaped. Latin numerals (I-IX) for the blade's outline and Arabic numerals for the blade's cross section (1-6) and its greatest width (01-03). Except for the two last groups the order of the groups is insignificant. However, a standard order should be preferred and I find that their order of presentation as described below is most convenient.

(1) the number of edges (A-K)
(2) the shape of the shafting part (a-g)
(3) the outline of the blade (I-IX)
(4) the cross section of the blade (1-6)
(5) the greatest width of the blade (01-03)

Any arrow-head that fits into this classification system may be classified and described by a combination of numbers and letters e.g. **EdIII22**. This is the most frequently found arrow-head from the Viking Period in Norway (= Rygh 1885 Fig. 339). It is an arrow-head with two side edges (E), a pointed tang with ledge (d), evenly curved (biconvex) blade outline (III) and diamond-shaped cross section (2). Its greatest width is in the middle of the blade (02). These five groups of attributes are not valid for all arrow-heads. Group 4 (cross section of the blade) is only valid for the two-edged, while groups 3 (the outline of the blade) and 5 (location of greatest width) are not valid for arrow-heads with internal edges.

The classification system does not include all attributes that may separate one arrow-head from another. However, the system should be comprehensive, simple and easy to use. For some arrow-heads other attributes may also be significant, but these may be given a supplementary verbal description. Valuable information is also collected when an arrow-head is measured.

Comparisons with former studies (Rygh 1885, Shetelig 1912, Hougen 1932, Fett 1940a, Serning 1956,1966, Farbregd 1972, Wegraeus 1973) show that most Scandinavian arrow-heads from the Iron Age fit into the system. Some arrow-heads from sami (lappish) votive finds, are difficult to classify. They have ordinary blade outlines but the transition from the blade to the shafting part is different from the standard of the Iron Age arrow-heads. However, they may be classified according to the shape of the blade and are considered as special variants of the Iron Age types.

The system does not solve all problems connected with the classification of iron arrow-heads, but it seems to be a suitable starting point for further studies. For more detailed studies of the types the system may be expanded.

3.0 MODEL ANALYSIS

Cluster analysis has been used in the testing of the classification system The computer programs used are included in the STAR package (Daltveit et.al. 1983). Cluster analysis is a method for grouping rather than for typing of artifacts. The strength of the method therefore lies in the testing of hypotheses of classes (types) rather than the establishing of types (Dunnel 1971, p. 184, Green 1975, p. 25).

Fragmentary data raises an important question when the method is used. Such data ascend the resulting dendrogram easily to the first few branches, but stop further branching which is based upon attributes they are lacking (Galloway 1976, p. 42). One may try to solve this problem by first making a model analysis based on known complete artifacts. If the model analysis is successful the probability of an objective and good use of the method on a real data set is high (Galloway 1976, Townsend 1977).

Cluster analysis, however, should not be used in testing monothetic classifications, which are most common in archaeology, because the analysis is based on polythetic occurrences of attributes (Whalton 1977). So is the classification system presented here, and the method should therefore be applicable.

Iron arrow-heads may suffer more from pervasive corrosion than larger weapons and utensils. This is especially the case in coastal districts of Hordaland. Arrow-heads found in the inland districts are generally better preserved.

Preliminary analysis showed that the chosen attributes should be weighted. Otherwise, the results seemed to be of no value at all. This was confirmed by the model analysis using non-weighted attributes.

The model analysis included 28 different arrowheads. This was a theoretical sample, but each chosen arrow-head possessed real equivalents. Most of the sample was made up of arrow-heads with two edges. This was done because the two-edged arrow-heads form the majority of the real data set, and because these arrow-heads have more attributes than others. Thus, these arrow-heads should be the best for testing the usefulness of the method.

When choosing the sample, I emphasized the number of edges, the shape of the shafting part and the outline of the blade. For most of the sample the blade's cross-section and the location of the greatest width are identical, but for those with an **a** tang these attributes also vary.

The first model analysis was made with unweighted attributes. The resulting dendrogram is presented in Fig. 6A. The similarity was measured by the Phi coefficient (cf. Daltveit et.al. 1983). The result of the analysis appeared to be good. However, the separation of the two-edged arrow-heads was not satisfactory. The **EaV** arrow-heads cluster with **Aa** and **Ba**, not with the other **Ea** arrow-heads. This is due to the **BaV**, the only other item with a socket (a) and a diamond-shaped blade (V). All of the other two-edged arrow-heads cluster together. Except for the **Ea** arrow-heads, the shafting part seems to have little influence on clustering, although it is assumed to be a chronologically important attribute.

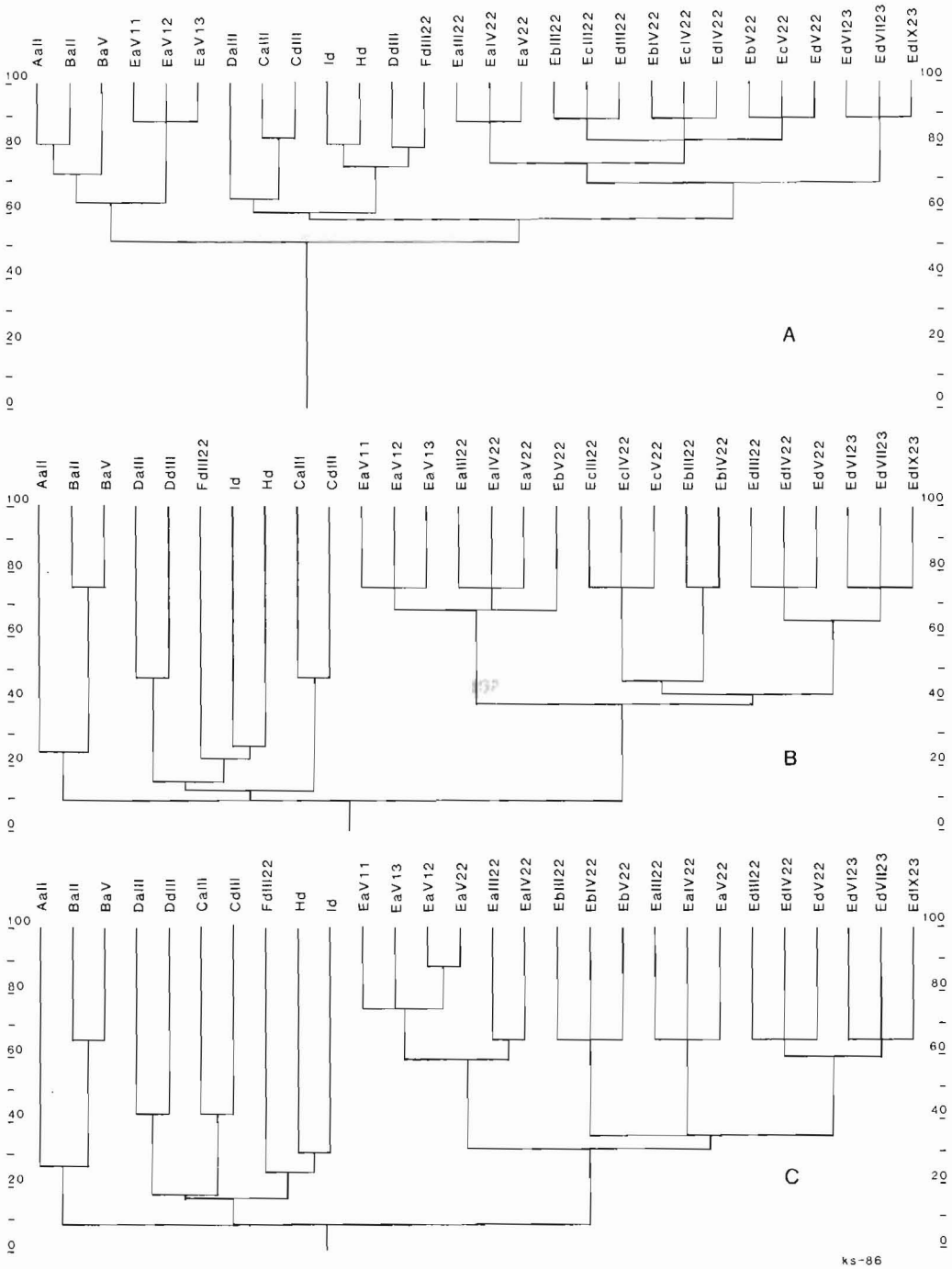

Fig. 6. Model cluster analysis of a test sample. A: unweighted, B and C weighted.

This unsatisfactory result is obviously due to the non-weighting of the attributes. I have therefore made two more model analyses with different weightings. This was done by giving the attributes different values. In the analysis presented as Fig. 6B, the number of edges was given the value 3 and the shafting part 2. The other attributes were given the value 1. The similarity (or rather dissimilarity) was measured by euclidian distance (cf. Daltveit et.al. 1983). This analysis gave a distinctly better result. All of the two-edged arrow-heads clustered together and arrow-heads having the same shafting part formed minor clusters. However, the result was still unsatisfactory. Some arrow-heads with different blade outline clustered together. This attribute should therefore be taken more into consideration.

In the third model analysis, all attributes were given separate values: the number of edges (6), the shafting part (5), the outline of the blade (3), the blade's cross section (2) and the width of the blade (1).

The similarity was measured by euclidian distance. Finally, the analysis gave a satisfactory result also for the two-edged arrow-heads. At the similarity level of 65, the two-edged arrow-heads with the same kind of shafting part but different blade outlines branch off. Those having the same blade outline but with different cross-sections of the blade branch off at the similarity levels 75 and 76. At the level of 88, arrow-heads with different locations of the blade's greatest width are separated (Fig. 6C).

These three similarity levels are of particular importance for establishing types among the two-edged arrow-heads. Level 65 should be considered as the level where the **types** branch. **Subtypes** branch at 75-76, while subtype **varieties** branch at level 88.

Thus, the model analysis resulted in that 25 types were represented among the 28 arrow-heads included in the sample. One of the types was represented by three subtypes and one of these by two varieties. The types of the two-edged arrow-heads are defined by the following three attributes:

1. the number of edges
2. the shape of the shafting part
3. the outline of the blade

These attributes also constitute the types of the other arrow-heads, but the outline of the blade is seldom relevant for these types.

4.0 ARROW-HEAD TYPES FROM HORDALAND

The total of 401 arrow-heads from Hordaland were known in 1975. Later finds are few and insignificant. 337 arrow-heads are found in 87 graves. 57 are stray finds and 7 are found at settlement sites. Many of these arrow-heads are strongly corroded and can not be classified.

The arrow-heads were classified by cluster analysis using the weight values from the third model analysis. Most of the classified arrow-heads are identical with at least one other arrow-head. Thus the number of different classified arrow-heads is 54. The resulting dendrogram is presented on Fig. 7.

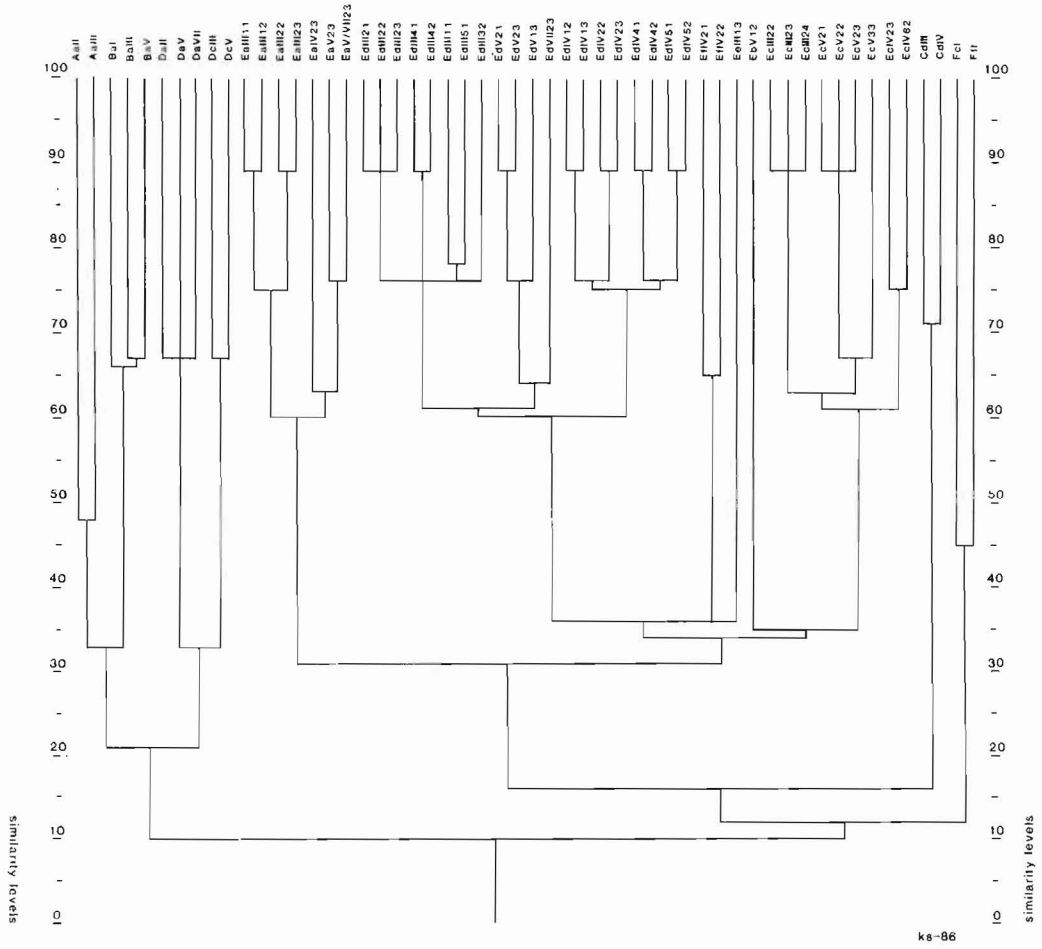

Fig. 7. Cluster analysis showing similarities between arrow-heads from Hordaland.

The dendrogram presents a nice and seemingly "correct" picture. Arrow-heads with different numbers of edges are grouped into separate clusters. Those having the same kind of shafting part cluster together etc. The types branch at different similarity levels. The multi-edged arrow-heads branch at lower levels than the two-edged. The **A** and **F** types branch between the similarity levels 45 and 48; the others between 60 and 72. Thirty types were found. Twenty-one of these are two-edged. The two-edged arrow-heads also show a greater variety than the others and are found in 26 sub-types and 45 varieties. Four sub-types are found among the types **EdIII** and **EdIV**. They also occur in the greatest number of varieties. Eight **EdIV** and seven **EdIII**. **EcV** and **EaIII** are present in four varieties each.

Approximately 300 arrow-heads from Hordaland were classified. Twenty-two arrow-heads without edges (**A**) are known from 8 finds. Twenty-one have straight converging sidelines and sockets, belonging to the type **AaII**. The last item has parallel side-lines (**AaI**). This was catalogued as an iron rod, 15.5 cm long, "resembling" a javelin head (Shetelig 1903, p. 33). However, remains of the wooden shaft still left in the socket indicates that it was used as an arrow rather than a javelin. The size and the weight of the head itself support this opinion.

Twenty-one four-edged (**B**) arrow-heads are known from 7 finds. Three types are found, all with sockets. Most of the arrow-heads have straight, converging edges (**BaII**). Two items have parallel edges (**BaI**) and one has a diamond-shaped blade (**BaV**). Three four-edged arrow-heads with divided blades (**C**) were found. Two are stray finds from the mountain plateau at Hardangervidda. The third was found in a grave in an adjacent valley.

Twenty-five of three-edged arrow-heads (**D**) were found. They come from 11 finds. Their variety is greater than for the **A**, **B** and **C** arrow-heads. a, c and e shafting parts are represented. They mostly have biconvex (III) or diamond-shaped (V) blades.

Most of the arrow-heads found in Hordaland have two edges. 233 of the classified items have such edges, but many lack the shafting part or are so heavily corroded that the outline of the blade can not be determined. Twenty have sockets (**Ea**), 2 flat tangs (**Eb**), 36 pointed tangs without ledges (**Ec**) and 143 have pointed tangs with ledges or thickenings (**Ed**). One arrow-head has a square tang without a ledge (**Ef**) and 2 have square tangs with ledges (**Eg**). Biconvex (**EaIII**) and diamond-shaped blade (**EaV**) are found among the **Ea** arrow-heads. One of the **Ea** arrow-heads is atypical, and has a non-symmetrical blade (**EaV/VII**). The two **Eb** arrow-heads are found in the same grave. They have biconvex blades (**EbIII**). This kind of tang is mostly found in eastern Norway (Hougen 1932, Farbregd 1972).

The **Ec** arrow-heads originate from 17 finds. Three different outlines of the blade are found, biconvex (**EcIII**), edge corners (**EcIV**) and diamond-shaped (**EcV**). The **Ed** arrow-heads come from 56 finds. Five different blades are represented: 94 **EdIII**, 24 **EdIV**, 6 **EdV**, 1 **EdVII** and 1 **EdIX**. In addition there were 25 arrow-heads were the outline of the blade was unknown. 69 **EdIII** arrow-heads have blades with a diamond-shaped cross section (**EdIII2**), one has a central rib (**EdIII3**), while 5 are hammered flat (**EdIII4**) and 7 have a shallow depression (**EdIII5**) in the central part of the blade. Three have flat blades (**EdIII1**). Thirty-five have their greatest width in the middle of the blade (**EdIII02**). Forty-five are widest in the upper part (**EdIII01**) and only 6 are widest in the lower part of the blade (**EdIII03**).

Eight arrow-heads with edge corners (**EdIV**) are widest in the middle of the blade (**EdIV02**), 8 are widest in the upper part (**EdIV01**) and 7 in the lower part (**EdIV03**). Two have flat blades (**EdIV1**), 8 have blades with a diamond-shaped cross section (**EdIV2**). Five arrow-heads are hammered flat in the central part of the blade (**EdIV4**), 6 have a small depression (**EdIV5**) and 1 a depression with central ridge (**EdIV6**). Among the **EdV** arrowheads are found flat blades (**EdV01**) and blades with diamond-shaped cross section (**EdV02**).

The **EdIII**, **EdIV** and **EdV** arrowheads are known from graves and as stray finds from mountain areas. The sole **EdVII** arrow-head is a stray find, while the **EdIX** arrow-head comes from a grave.

Three two-edged arrow-heads have tangs with a square cross-section. One is medieval and lacks a ledge (**Ef**). The other two have ledges and come from a Merovingian Period grave. Two arrow-heads with forked edges are grave finds. Both have tangs, one pointed (**FcIII**) and one with square cross-section (**FgIII**).

5.0 CHRONOLOGY

As previously mentioned the different tangs seem to belong to different periods. Flat tangs were common in the Migration Period (AD 400-600) (Shetelig 1914, p. 75, Hougen 1932, p. 69, Farbregd 1972, p. 16). Pointed tangs without ledges or thickenings largely belong to the Merovingian Period (AD 600-800); while pointed tangs with ledges should generally be dated to the Viking Period (AD 800-1000) (Farbregd 1972, p. 22).

Six finds containing **AaII** arrow-heads are dated to the first half of the 6th Century. This type is only so late in Hordaland (Fett 1940a, p. 39). The **AaI** arrow-head is somewhat younger. Five finds containing **Ba** arrow-heads are also dated to the 6th Century. Only one **C** arrow-head was found in a datable context, in a grave from the 10th Century (Fig. 8).

Ten finds containing **Ea** arrow-heads are dated, all to the 6th Century. These are both **EaIII** and **EaV**. The find with the atypical **EaV/VII** arrow-head is dated to c. 600 AD. One **EaVI** arrow-head is dated to the Merovingian Period. The last three dated **Ea** arrow-heads are from the Viking Period. The two **EbIII** arrow-heads originate from the same find, which is dated to the Merovingian Period. This is later than the general dating of the types with flat tang.

Only a few finds of **Ec** arrow-heads are dated. Four finds are from the 6th Century, 2 from the Merovingian Period and 3 from the Viking Period. This is a wider dating than expected, but such early and late datings are known from before (Farbregd 1972, p. 22). Most of the **Ed** arrow-heads are dated to the Viking Period, but three finds belong to the Merovingian Period. The two **Ef** arrow-heads are from the same find and are dated to the Merovingian Period.

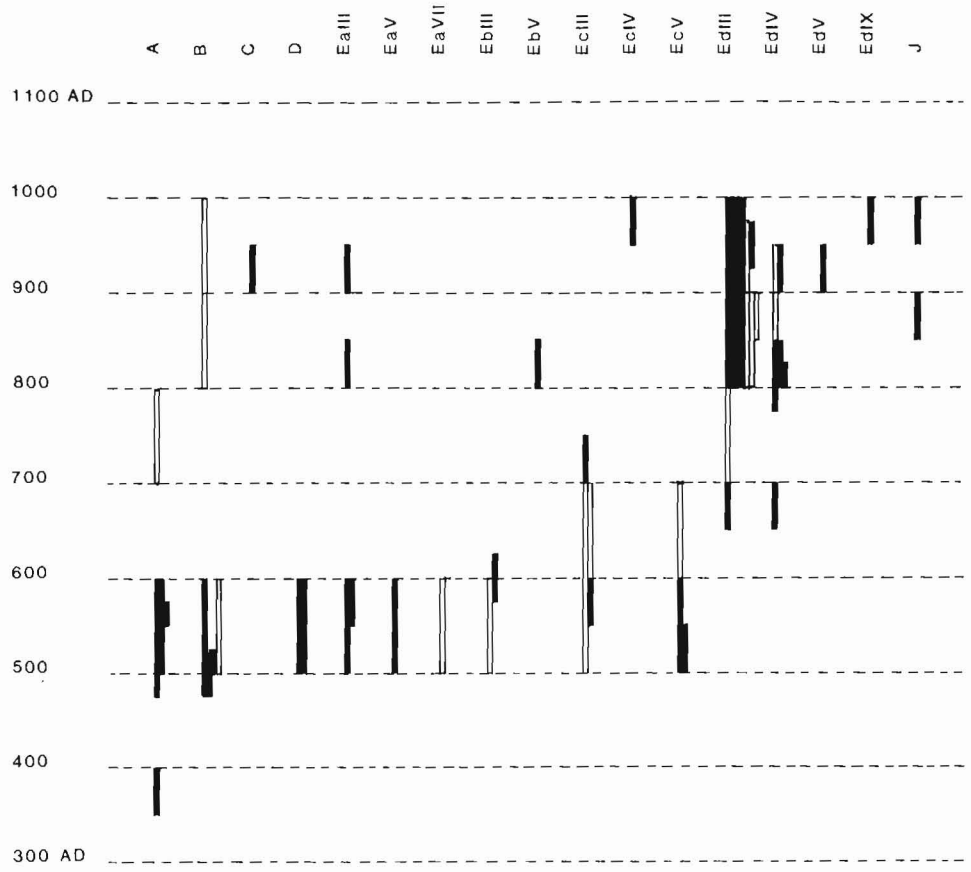

Fig. 8. Dated grave finds from Hordaland containing arrow-heads. Open rectangles indicate uncertain dates.

6.0 GEOGRAPHICAL DISTRIBUTION

Like the other western Norwegian counties, Hordaland is dominated by mountains and fjords. The fjords cut deeply into the land massif, making the sea the natural traffic route for most of the population. Only 10 % of the county's population lived more than 5 km away from the sea in 1950 (Sund & Malmo 1951). Most of the arable land is found below the late Pleistocene marine limit. In fjord districts, the soil is mostly morainic except at the inner ends, where glaci-fluvial deposits are frequently found. Short, steep valleys lead from the fjords to mountain plateaus.

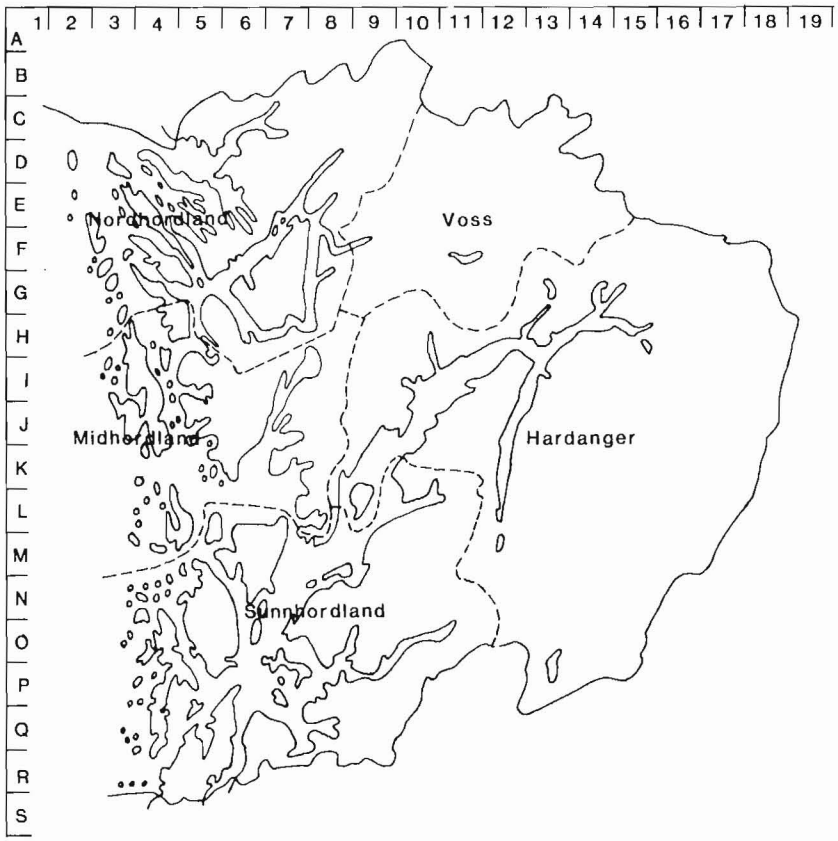

Fig. 9. The districts of Hordaland. The map also shows the grids used in the analysis.

In contrast with the fjords, much land at the coast was affected by the postglacial uplift, and the marine limit here constitutes a distinct upper boundary for agricultural settlement. Most of the arable soil in these areas consists of sand and gravel or bogs. A major limitation for agricultural development in western Norway is the scarcity of arable soil. A second factor is the large quantity of precipitation (Sømme 1954, p. 150-51).

Today Hordaland is divided into five districts; Voss and Hardanger in inland areas and Nordhordland, Midhordland and Sunnhordland at the coast (cf. Fig. 9).

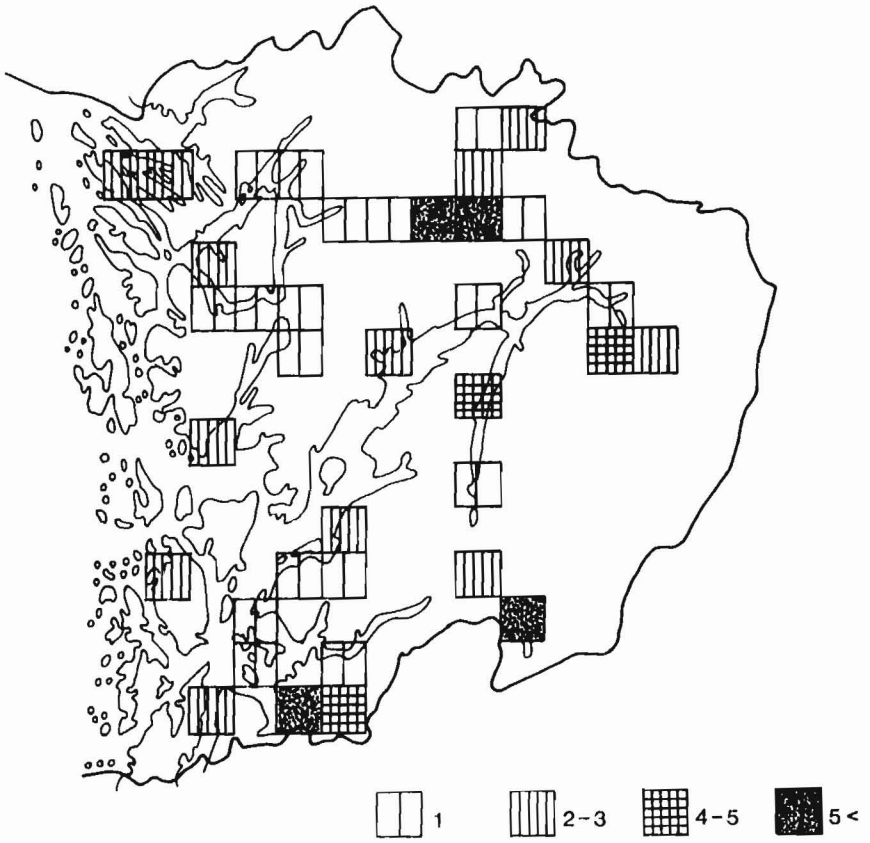

Fig. 10. The distribution of graves containing arrow-heads in Hordaland.

Arrow-head finds were plotted on a map with a grid system where each grid covers an area of 10x10 km. This was done in order to facilitate presentation and statistical analysis of the data set. The grid system is presented on Fig. 9.

The distribution of the grave finds containing arrow-heads reflects the settlement pattern. They are found scattered throughout the county (Fig. 10) but mainly in Sunnhordland, Voss and Hardanger. All stray finds come from inland districts (Fig. 11). Most of them are found on the Hardangervidda mountain plateau and should be interpreted as remains from hunting expeditions. The majority of finds (23) come from Eidfjord parish in Hardanger. Sixteen finds come from Vangen parish in Voss and 12 from Røldal parish in Hardanger.

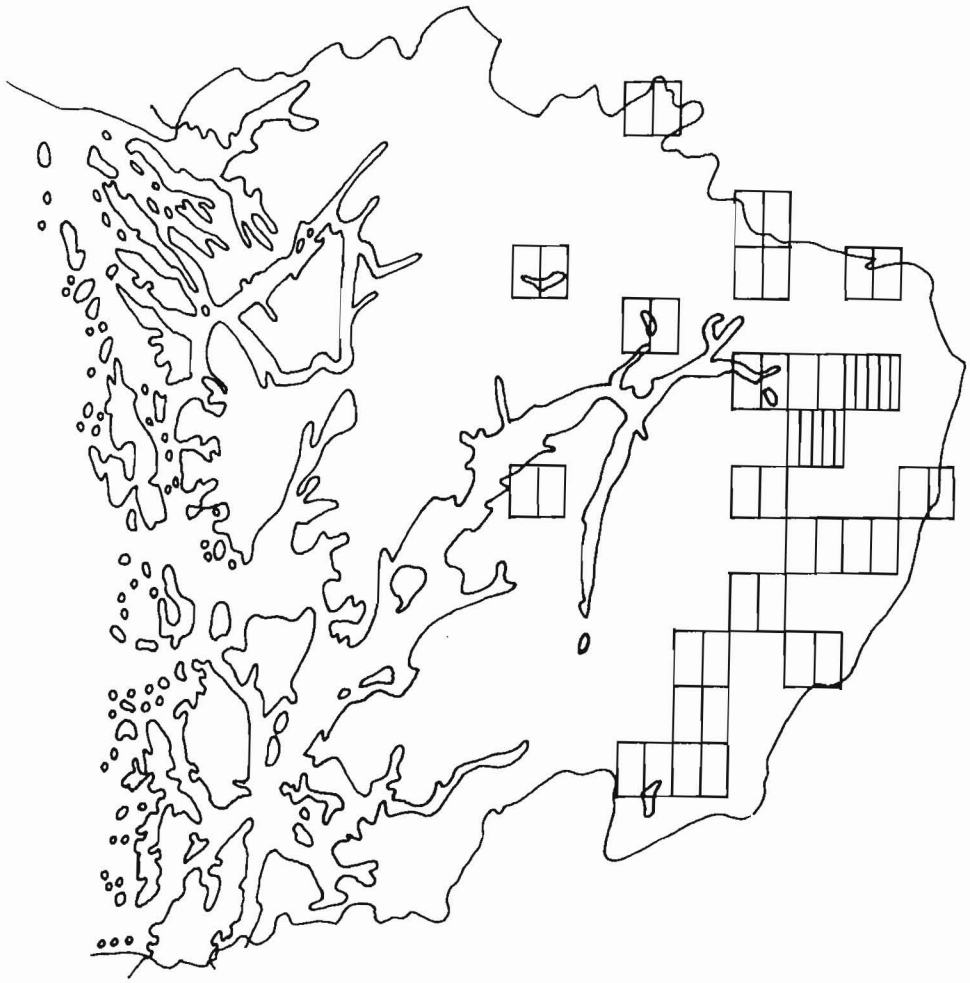

Fig. 11. The distribution of arrow-head stray finds from Hordland. Legend see Fig. 10.

The geographical distribution of the arrow-heads from Hordaland was analysed by correspondence analysis. This analysis measures the correspondence between units and variables as plotted into a n-dimensional space. The outcome of the method is joint plots of the representations of units and variables in various two-dimensional sub-spaces. The significance of each of the two principal axes can be judged by their percentage contribution to the total. By projecting the variables on to the coordinate axes and studying their locations with respect to the origin, a picture emerges showing which variables are "responsible" for the axes. This picture may sometimes be archaeologically significant and interpretable as an archaeological effect such as chronology or function (Bølviken et

Table I. Distribution of arrow-heads from Hordaland.

	C13	D4	D5	D12	E8	E10	E11	E12	F6	F14	G6	G15	H8	H15	H16	I12	J6	K12	L9	M8	M12	N13	O9	P8	P9	
AaII	1	-	7	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	--	-	11	-	20
AaIII	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1
BaI	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
BaII	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	5	-	11
BaV	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	2
CdIV	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
DaII	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
DaV	-	-	4	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
DaVII	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
EaIII	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	2	-	4
EaIV	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2
EaV	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
EaV/VII	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
EbV	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
EcIII	1	-	2	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	4	-	-	1	-	-	-	12
EcIV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	2	-	-	-	3
EcV	-	-	-	-	-	-	-	-	5	-	-	5	1	-	-	-	-	-	-	-	-	-	-	-	-	11
EdIII	-	-	-	-	-	1	16	9	-	4	-	-	4	8	10	1	-	1	-	-	-	6	-	-	-	60
EdIV	-	-	-	-	-	-	1	2	-	-	-	-	-	3	12	-	-	-	-	-	-	3	-	-	-	21
EdV	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	4
EfIV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	2
JcI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1
FfI	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
	4	2	14	1	1	1	19	13	5	5	2	9	5	11	23	3	4	1	6	1	1	12	-	20	1	168

al. 1982). The method used is described in the STAR package (Daltveit et.al. 1983).

All classified arrow-heads were included in the analysis. The number of arrow-heads found in each grid is presented in Table I. The stray finds and the finds from settlement sites were included in the table. In the analysis the types served as units, while the grids were variables. Some of these variables acted as statistical noise giving extreme values with a heavy impact on the result. In the final analysis the grids D4, D12, M8, M12, P9 and the stray finds had to be deleted. Thereby the types **AaI**, **BaI**, **CcIII**, **DcV**, **EaV/VII**, **EdVII**, **EfIII** and **EgIV** were also deleted.

The resulting diagram is presented in Fig. 12. The two principal axes represent 32.99 % of the n-dimensional plot, 17.48 % for axis 1 and 15.51 % for axis 2. Both types and grids are scattered over most of the diagram, but the diagram still shows a strong tendency towards clustering. One cluster is found in the upper, left-hand part of the diagram. It includes the types **AaII**, **BaII**, **DaII**, **DaV** and **DaVII**. These types are all dated to the Migration Period. The grids represented in the cluster are D5 in Nordhordland, J6 in Midhordland and P8 and P9 in Sunnhordland. This cluster shows a strong correspondence between arrow-heads from the Migration Period and grids from coastal districts.

Below this cluster the type **EaV** and the grid G13 stand together. Again a Migration Period type, but this time linked to an inland grid (Voss). In the lower, central part of the diagram the Merovingian Period types **EcIII** and **EcV** are found together with the grids L9 from Sunnhordland and G15 from Hardanger.

The main cluster is dominated by Viking Period types and grids from the districts Hardanger and Voss. Some earlier types, **BaV**, **DcIII** and **DcV** as well as the coastal grids G6 and H8 from Midhordland are attached to this cluster.

The analysis demonstrates both chronological and geographical differences in the data set. A correspondence between certain types and districts was found. Most of the arrow-heads from the Migration Period are found in coastal districts, while most of the Viking Period arrow-heads are found in inland districts. The Merovingian arrow-heads have an intermediate geographical distribution.

The stray finds had to be deleted from the analysis. This means that these finds have a chronological and/or geographical distribution which differ significantly from the grave finds.

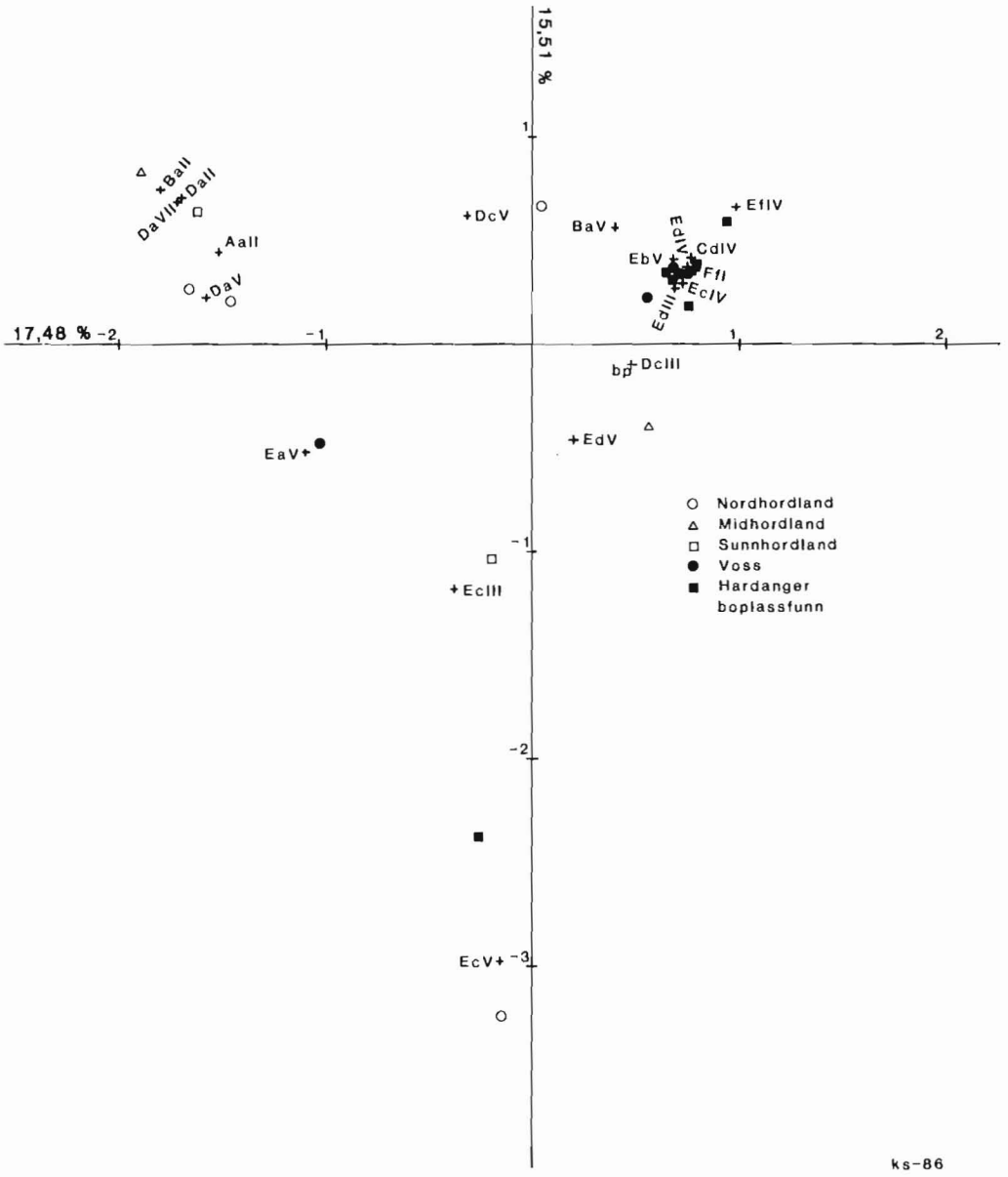

Fig. 12. Correspondence between arrow-head types and grids in Hordaland.

Table II. Distribution of two-edged arrow-head subtypes in Hordaland.

	C13	D5	D12	E10	E11	E12	F6	F14	G6	G15	H8	H15	H16	I12	K12	L9	M12	N13	P8	P9	bp	lf	
EaIII1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2
EaIII2	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	2	-	-	4	8
EaIV2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
EaV2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
EaV/VII	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
EbV1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
EcIII2	1	2	-	-	-	-	-	-	-	4	-	-	-	-	-	4	-	-	-	-	1	3	15
EcIV2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	1	3
EcV2	-	-	-	-	-	-	5	-	-	5	-	-	-	-	-	-	-	-	-	-	-	2	12
EcV3	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
EdIII1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	3	4
EdIII2	-	-	-	1	15	7	-	4	-	-	4	6	4	1	1	-	-	6	-	-	1	16	66
EdIII3	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1
EdIII4	-	-	-	-	-	2	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	5
EdIIIV	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	5
EdIV1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	1	3
EdIV2	-	-	-	-	1	2	-	-	-	-	-	2	1	-	-	-	-	2	-	-	-	3	11
EdIV4	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	1	4
EdIV5	-	-	-	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	-	-	8
EdV1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
EdV2	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	4
EdVII2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
EeIII1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
EfIV2	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	2
	2	2	1	1	18	12	5	4	1	9	5	11	23	3	1	6	-	11	2	1	2	40	160

The diagram presented on Fig. 12 is strongly influenced by the fact that the arrow-heads from the Migration Period and those from the Viking Period are so differently distributed. Therefore, I have made a second analysis of the two-edged arrow-heads alone. The number of arrow-heads found in each grid is presented in Table II. In this analysis sub-types where chosen as units. The resulting diagram is shown on Fig. 13. The two principal axes represent 42,13 % of the n-dimensional plot, 22.80 for axis 1 and 19.33 for axis 2. This diagram also has one major cluster, which is separated from two minor clusters by axis 1. In the major cluster most of the Viking Period arrow-heads and also the Migration Period sub-type **EaV2** are found. Grids found in this cluster are E10, E11 and F14 from Voss, H15, K12 and N13 from Hardanger, G6 and H8 from Midhordland and P8 from Sunnhordland.

There is a smaller cluster containing the sub-types **EdIII5**, **EdIV4**, **EdIV5** and **EdIV6** and the grid H16 in the lower left-hand part of the diagram. These sub-types are only known from one find, B 7658 from the farm Åstestølen in Eidfjord parish, Hardanger (fig. 14). In the lower right-hand part of the diagram a third cluster is found. Here the Merovingian Period sub-types **EcIII2** and **EcV2** occur along with the grids D5 and F6 in Nordhordland, L9 in Sunnhordland, C13 in Voss and G15 in Hardanger. This is a wider distribution than was indicated by the first analysis. The two-edged arrow-heads from the Migration Period (**EaIII2**) follow the Viking Period arrow-heads in the major cluster.

The stray finds and arrow-heads found on settlement sites are included in the analysis. This means that there is a geographical and chronological correspondence between the two-edged arrow-heads found in graves and the stray finds.

This analysis confirms the result obtained by the first correspondence analysis. The distributions of the two-edged arrow-head subtypes are relatively homogenous. Most of the types are found in the same grids in the two inner districts, Voss and Hardanger, and most of them should be dated to the Viking Period.

7.0 DISCUSSIONS

The different distribution patterns of the Migration Period and the Viking Period arrow-heads may be explained in several ways. Firstly, it may be due to different conservation conditions: differences in precipitation, soil permeability, air salinity etc. The impact of these factors on Iron Age finds from Hordaland has never been investigated. However, after studying the material my general impresssion is that the coastal finds are most strongly corroded. The best preserved artifacts are found in the inner

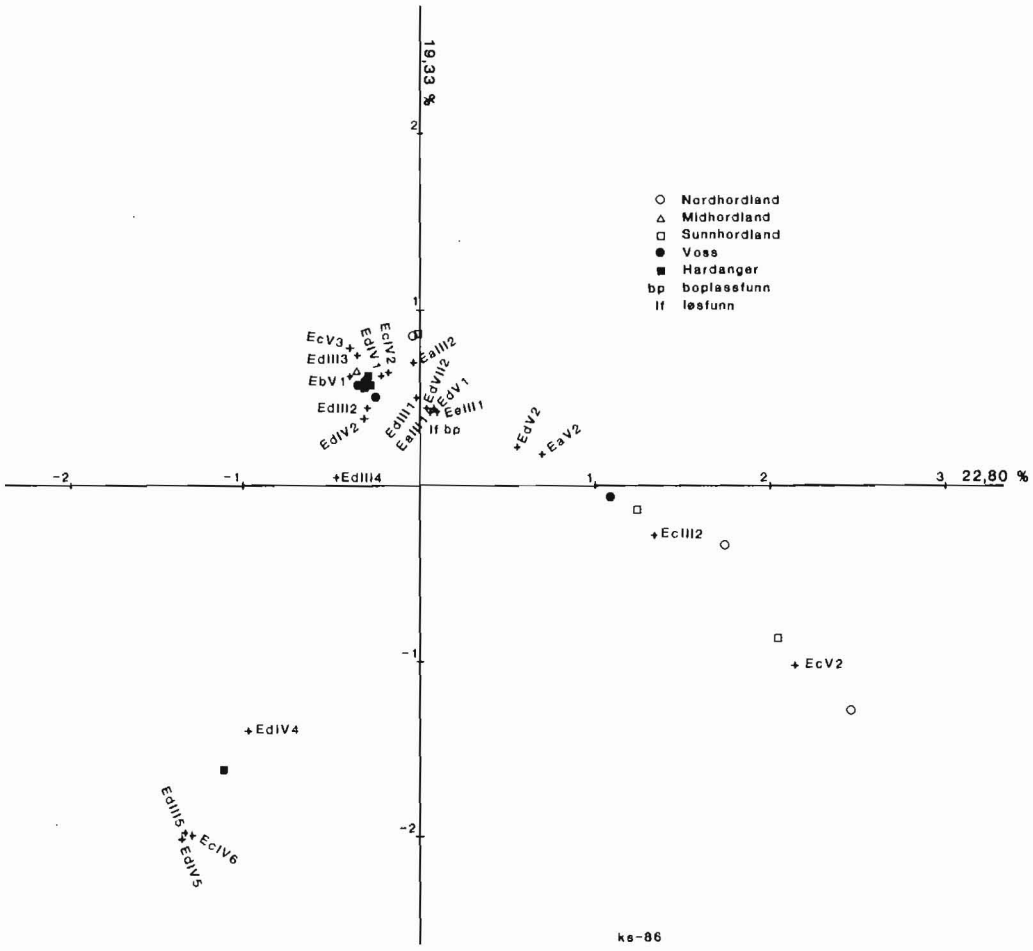

Fig. 13. Correspondence between two-edged sub-types and grids in Hordaland.

districts, particularly at higher altitudes. The relatively small awl-like arrow-heads from the Migration Period may be missing because they were dissolved faster than the larger and younger ones or because the corrosion has taken place for a longer time. This explanation does not explain the fact that the oldest and smallest arrow-heads are found in the districts with the least favourable physical conditions.

Secondly, since most of the arrow-heads are found in graves, the distribution pattern may reflect different burial customs. Neither does this explanation seem to be relevant. The burial customs were similar for the entire county throughout the Iron Age. Relatively rich finds from the Migration Period are excavated in coastal as well as inland districts (e.g. Shetelig 1912). Except for the absence of arrow-heads in the inner districts, there does not seem to be any significant difference between male graves from the different districts.

Arrow-heads are almost absent from coastal districts in the Viking Period. Etne parish in Sunnhordland seems to have been economically one of the county's most important places in the Viking Period (Sognnes 1979, p. 79f). In spite of its importance and relatively many grave finds, very few arrow-heads are found. The conditions are similar in Kvinnherad, also in Sunnhordland. Both Etne and Kvinnherad were also important Migration Period centres.

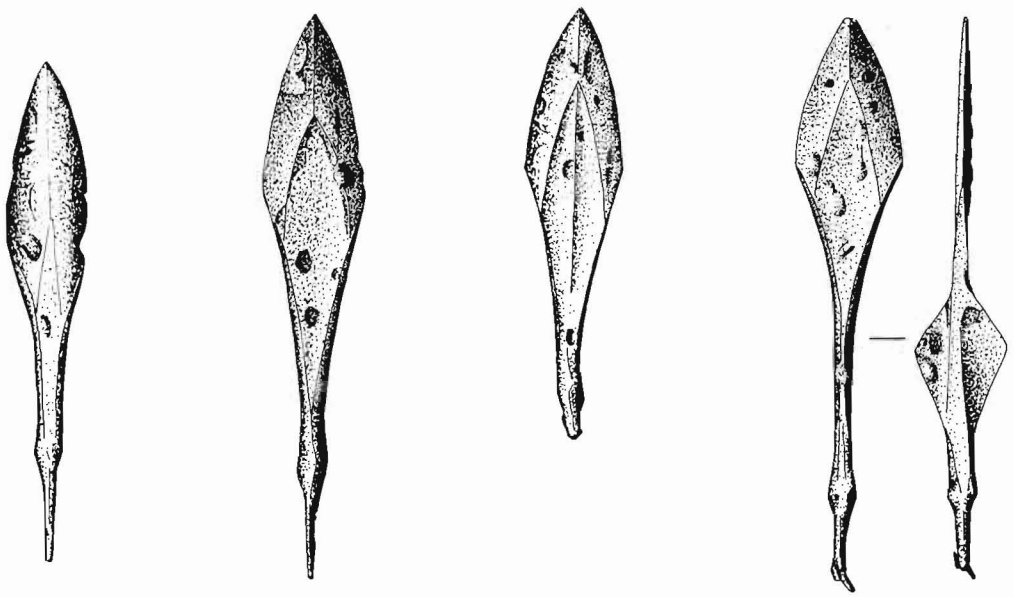

Fig. 14. Hunting arrow-heads found in a Viking Period grave at Åstestølen in Eidfjord, Hardanger.

Thirdly, the distribution pattern may be due to real differences in the use of arrow-heads in the Iron Age communities of Hordaland. This means that the deposition of arrow-heads in the graves reflects actual differences in their usage. The Migration Period is generally considered as having been a period of unrest and warfare. This is documented by weapons in the graves as well as by numerous hill-forts. Therefore, we should also expect to find arrow-heads together with other weapons in the inner districts. When evidence for this is lacking, an explanation should be sought. The Migration Period in western Norway is archaeologically characterized by extenstive import of foreign luxuries, glasses, bronze vessels etc. This import indicates close trade connections with the Continent (e.g. Slomann 1956, Magnus & Myhre 1976, Hagen 1977). Imported and exported goods must have been transported along the coast where local communities seem to have established a comprehensive trade system (e.g. Farbregd 1980). The participants in this system most surely felt the need for protecting their interests against piracy and looting.

The distribution of the Viking Period arrow-heads should be explained differently. During the Viking period, the inner districts in western Norway seem to have been the most important economically. The coastal districts, and probably also the traffic along the coast, did not play the same role as before (Sognnes 1980). The wealth of the inner districts seems to have been based on utilisation of local resources; hunting, iron production, quarrying etc. There were probably trading contacts with the valley communities in eastern Norway, as well as direct contact with the Continent and the British Isles (Sognnes 1979). In Hordaland, Voss (Vangen), Eidfjord and Røldal stand out as the most important parishes in the inner districts. Eidfjord and Røldal are situated near the Hardangervidda mountain plateau. Hunting and traffic to eastern Norway across the plateau probably gave these communities their wealth. In Voss, wealth was probably related to iron production.

The Viking Period was also a period of unrest and warfare. However, most of the warfare seems to have taken place abroad in connection with conquering, settling and looting in the British and North Atlantic Isles. At home chieftains and petty kings struggled for power. These struggles ended in the late 9th Century with the establishment of the Norwegian state. However, it is difficult to decide how strongly these aristocratic affairs affected the common farmers and peasants of western Norway.

The Viking Period arrow-heads were clearly used for hunting purposes. This is well documented by the stray finds in the mountain areas in eastern and western Norway. The arrow-heads found in graves in adjacent communities are identical with the stray finds and most probably should primarily be interpreted as hunting weapons as well (cf. Hougen 1932). The arrow-heads could and most probably were also used in warfare.

The weapon set from the Late Migration Period consisted of a sword, a shield, bow and arrow and two light throwing javelins (cf. Fett 1940a,b). In the Viking Period weapon set the wide-edged weapon axe supplemented the sword and the two light javelins were replaced by a heavier spear which was probably not used for throwing. The warfare seems to have developed toward hand to hand combat, where there was less use for bow and arrows.

8.0 SUMMARY

The analysis presented here comprises approximately 400 Iron Age arrow-heads made from iron, all found in the county Hordaland in western Norway. About 300 arrow-heads were classified according to a previously presented classification system (Sognnes 1977). This system is based on morphological criteria: the number of edges, the shape of the shafting part, the outline of the blade, the section of the blade and the blade's greatest width.

The classification system was tested by cluster analysis. A model analysis showed that the attributes should be weighted. Three attributes, the number of edges, the shape of the shafting part and the outline of the blade constitute the types.

In the actual analysis 30 types were found. Twenty-one of these have two edges. The two-edged arrow-heads also show a greater variety than the single- and multi-edged ones and are found in a great number of subtypes and varieties.

The geographical and chronological distributions were tested by correspondence analysis. Arrow-heads from the Migration period are mostly multi-edged and are found in coastal districts. They are all found in graves, are awl-like and were most probaly used for warfare.

However, most of the arrow-heads found have two edges and were used in the Viking Period. They are largely found in fjord districts. They are found in graves or as stray finds in hunting grounds on the mountain plateaus. The graves are found in parishes surrounding the mountain plateaus, and contain the same types as are found in the mountains. The arrow-heads found in the graves therefore probably also were used for hunting.

Arrow-heads do not seem to have played any significant role in Viking Period warfare. Other changes in the weapon set from the Migration Period to the Viking period also indicate a transition to a more hand-to-hand combat which had less use for bows and arrows.

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