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ABSTRACT

Scandinavian Glass Vessels of the First Millennium AD - A

Typological and Physical Examination

Ph.D Thesis. J. R. Hunter, Department of Archaeology,

University of Durham. June 1977

The thesis is concerned with the study of Scandinavian glass vessels of the first millennium AD. It examines the significance of these artefacts in early society and considers in detail the archaeological contexts of burial and occupation site. A major part of the study is concerned with methodology and the problem of fragmentary material. A detailed typological analysis is made using new methods of data presentation enabling chronological, geographical and typological information to be presented simultaneously with the aid of computer facilities. The results of this are compared to data derived from the physical examination of selected samples by electron beam micro-probe analysis (major elements) and neutron activation analysis (trace elements). The results indicate that the distribution of glass within Scandinavia is more complex than originally thought. Two areas of origin appear to have existed one of which may lie within Scandinavia itself.

The work is presented in two volumes, the first containing the text and the second containing a detailed catalogue of all glass vessels and fragments discovered in Scandinavia together with relevant descriptions, information regarding archaeological context and references.

Scandinavian Glass Vessels of the
First Millennium AD - A Typological
and Physical Examination.

VOLUME ONE - Text

John Rotheram Hunter

Ph.D Thesis

Department of Archaeology,
University of Durham.

June 1977.

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PREFACE

This thesis is concerned with the study of Scandinavian glass vessels of the first millennium A.D. It examines the significance of these artefacts in early society and considers in detail the archaeological contexts of burial and occupation sites. A major part of the study is concerned with methodology and the problem of fragments. A detailed typological analysis is made and this is compared to data derived from two different methods of physical examination on selected samples.

The work is presented in two volumes, the first containing the text and the analytical reports and the second containing a detailed catalogue of all glass vessels and fragments discovered in Scandinavia. Cross-reference to the catalogue is made by quoting the individual catalogue entry number in parenthesis in the main text. The chronological definitions adhered to throughout are those of the Swedish system and refer to the Roman, Migration, Vendel and Viking Periods. A fuller explanation of this system is given in chapter four.

ACKNOWLEDGEMENTS

So many individuals and institutions have been responsible for guidance and assistance in this work that it is impossible to indicate the debt I owe them adequately here. Among those in this country my deepest gratitude goes to my supervisor Professor Rosemary Cramp of the University of Durham who first inspired me to study early glass and whose continual advice and encouragement throughout was so fundamental to the completion of the work. On the technical side I am indebted to Mr. Arnold Aspinall of the University of Bradford for patiently teaching me the principles of neutron activation analysis and to Mr. John Crumett for his valuable technical advice and computer expertise. Dr. Andrew Peckett of the University of Durham was responsible for the majority of the major element analyses and I am indebted to his skill and knowledge. Professor Roy Newton, now at the University of York, was invariably a source of new ideas and information and his friendly advice on the technical problems of glass analysis and data presentation were of inestimable value to me. Among others in England whose advice is gratefully acknowledged are Dr. Vera Evison of Birkbeck College, London, Dr. Donald Harden of the British Museum, the late Dr. David Clarke of Peterhouse College, Cambridge and Dr. David Wilson, now Director of the British Museum. All listened to my problems patiently and I am indebted to their great knowledge and scholarship.

The year spent in Scandinavia was financed by the British Council to whom I am extremely grateful for making this possible. I would like to extend my thanks to the staff of the Lunds Universitets Historiska Museum where I was based, in particular to Professor Mats Malmer, now

at the University of Stockholm. While at Lund there was always a ready ear and eager encouragement from the Museum staff and this was greatly appreciated. I am indebted to Dr. Schönback, Director of the Iron Age Department in the Statens Historiska Museum, Stockholm for allowing me to sample glass vessels in the museum. Without his enthusiasm for the project none of the analytical work would have been possible. Also in Stockholm Professor Willheim Holmquist and Dr. Agneta Lundström from the Helgö excavations were both invaluable with their advice and suggestions and continued to offer assistance even when I had returned to England. I would like to acknowledge the kind assistance of Dr. Erik Nylén of the Visby Fornsal, Gotland for allowing me to sample the Gotlandic material and for his valuable discussions on Baltic settlement and trade. Dr. Ulf-Erik Hagberg of the University of Uppsala is directly responsible for my knowledge of the archaeology of Öland and even provided a summer cottage to allow me to stay and study the material. His friendship was typical of many others and I am deeply grateful for his consideration and advice.

Many individuals were kind enough to allow me to examine their unpublished material. Professor Berta Stjernquist and Dr. Tom Ohlsson of the University of Lund, Sweden, Mr. Arne Hällström of the Visby Fornsal, Gotland, Dr. Jan-Peder Lamm of the University of Stockholm, Sweden, Mrs. E. Thorvildsen of the National Museum, Copenhagen, Denmark and Dr. Wenke Sloman and Dr. Ellen Hougen from the University of Oslo, Norway were all magnanimous in this respect and their help was deeply appreciated.

Additional advice and assistance was given in every quarter.

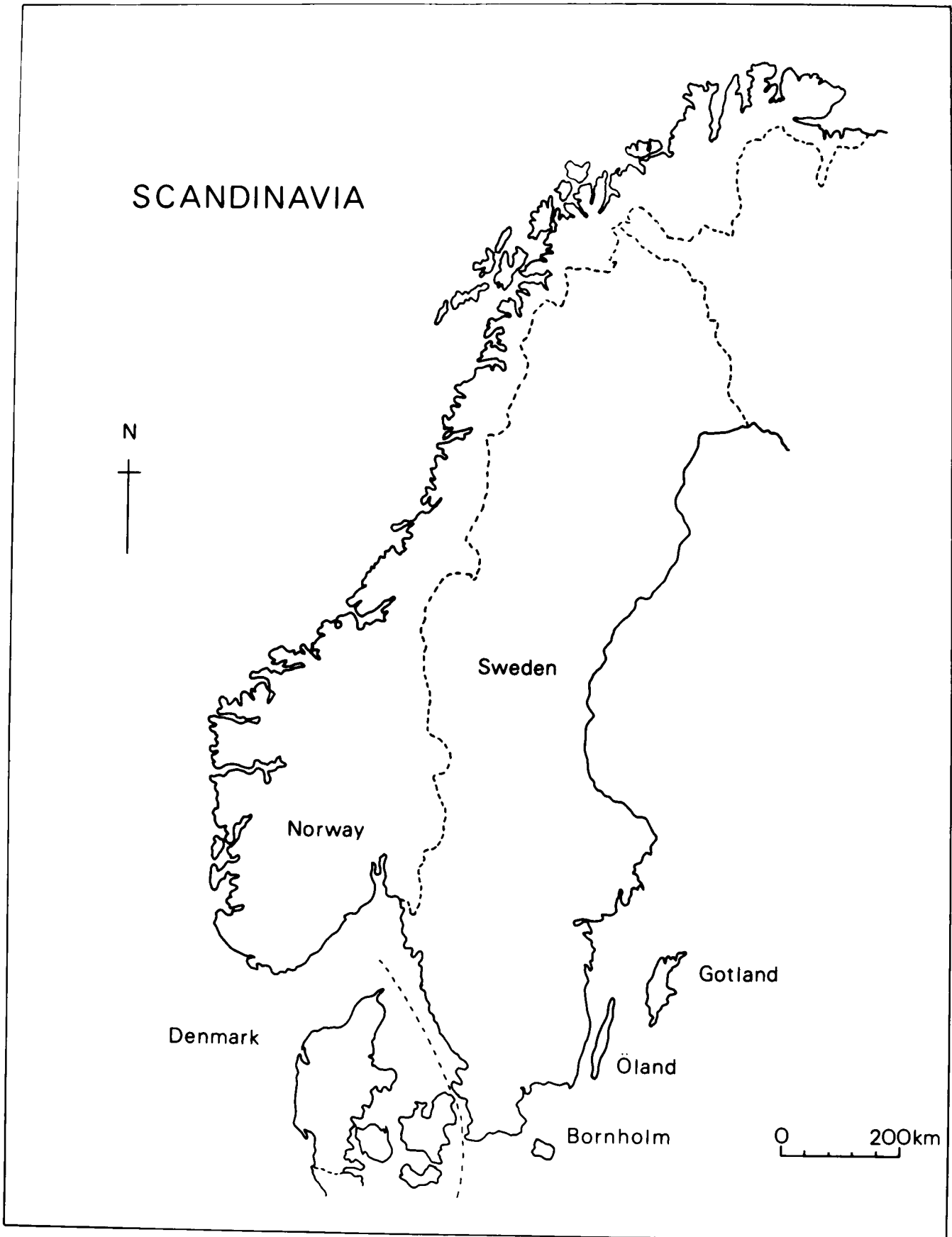
I would particularly like to extend my thanks to Dr. Elizabeth Munksgaard of the National Museum, Copenhagen, Denmark, Professor Becker of the University of Copenhagen, Denmark, Professor Moberg and Dr. Carl Cullberg of the University of Gothenburg, Sweden, Mrs. Charlotte Blindheim of the University of Oslo, Professor Greta Arwidsson of the University of Stockholm, the late Professor Mårten Stenberger of the University of Uppsala, Dr. Henrik Thrane of the Odense Museum, Denmark, and to the staff of the Norwegian museums at Bergen, Oslo and Stavanger. The encouragement and helpful discussion offered by these numerous people acted as a continual inspiration and to all of them I offer my sincere thanks.

Finally my wife Margaret deserves the greatest thanks of all for tolerating thousands of miles of travel, late nights and constant interruptions to her own life. Without her this thesis would never have been written and it is to her and our son Edward who was born in the middle of it all that this thesis is dedicated.

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CHAPTER ONE - GLASS AS AN ARTEFACT

Our knowledge of early glasses is derived from the researches of numerous scholars. The subject has been reviewed periodically when new objects appeared or when fresh evaluation seemed necessary (1). The works published on the subject differ in aim, method and in range of material used and consequently have a tendency to confuse rather than enlighten any reasonable survey of glass history. Inconsistencies of terminology, differences in chronology and a persistent disregard for the study of glasses within a social context have all combined to form this picture. The accepted conventions produce works which either concern themselves with a total evaluation of a small number of typologically similar objects or with a generalised survey defined chronologically. In the latter the relevance of the chronological limits is rarely explained. There are few works which combine a comprehensive catalogue of objects and a broad chronological frame-work that allows systematic typological development to be traced.

The situation is not confined to glass, or for that matter only to artefacts. Malmer has already shown that on the broadest scale the very systems on which archaeological studies are based are open to criticism (2). The earliest prehistoric periods are approached and defined using geological, climatological and other environmental links. The later metal ages are defined chronologically. The Scandinavian Iron Age, although divided chronologically is essentially defined by typological change in various artefacts. Malmer's aim is to unify the comparative approaches at all levels of archaeology. He sees consistent and uniform methods of description as being fundamental to the proper understanding of

archaeological remains. Without doubt his suggestions are valid but the practical difficulties which emerge are so formidable that they are almost impossible to carry out fully. Nevertheless, his ideas reflect the major elements of contemporary archaeological thinking and wherever possible in this study effort has been made to follow them.

A large proportion of the Scandinavian material was discovered from excavations which took place as early as the nineteenth century. This consequently presents problems regarding the validity of the documentation and recording. Although one must acknowledge certain shortcomings in this heritage one cannot reject outright works which were undertaken according to the conventions of earlier times. Not only has the archaeologist to evaluate his own material but also has he to verify those sources on which he has cause to rely. It is at times when the value of standard works such as Werner's "Münzdatierte austrasische Grabfunde" is examined in terms of its sources and found to be suspect that one realises the potential danger of accepting without question earlier research (3).

As any corpus of archaeological artefacts is continually growing it becomes all the more important that the methods used to describe the material are precise, clearly defined and are applied equally to all items under consideration. The next scholar will invariably reconsider the study in the light of new finds and produce a new interpretation. The least we can do is to ensure that all the available material is recorded for him in a way that will allow him to gain rapid information and to add his own data without difficulty. "No archaeologist can ever describe his records in such a way that his successors do not need to return to them" (4). It is important in any descriptive and classifying process that accurate and empirical methods should be used to allow this type of continuity of

interpretation to be maintained. This is not to suggest that an ordered methodology is solely to assist the evolution of archaeological interpretation. That is only one aspect. By using the maximum value of the material in an ordered manner - that is to say when all the items have been subjected to the same criteria at the equivalent stages of description - one is likely to achieve a more accurate understanding of artefacts and the people who used them than by any other method. One is doing no more than taking the logical and defined procedures of pure science and applying them to archaeological material.

A general treatise on method would hardly answer my earlier criticisms. The understanding of peoples and artefacts is not attained solely by objective classification any more than by subjective reasoning. Most works devoted to glass have been concerned merely with glass as an isolated object. Rarely is the significance and function of the item questioned and even more seldom does one read of the problems concerning the relationship between the glass vessel and the nature of the site or burial from which it was found. Glass studied in this way disregards the importance of the social environment. The initial stage of method lies in an evaluation of the sociological implications and not of the typological. Origins and functions must be considered before any system of typology is established and the starting point for this lies in the archaeological context of the material in question. The only real way of understanding how or why the object was used is to examine meticulously all the relevant site evidence.

The Archaeological Context

For the purpose of this work it is assumed that glass remains are limited to three main classes of find situation, inhumation graves, cremation graves and culture layers. Included in the last class are chance finds and those from destruction layers.

Inhumation graves usually provide the best preserved vessels although there are many such graves which only produce fragmentary glass. It has often been considered that vessels from inhumation graves were usually intact at the time of burial and therefore should remain complete until the time of initial discovery. This is not always the case and there are several exceptions a notable example being an inhumation in which a single glass fragment was seemingly laid symbolically ⁽⁵⁾. The significance of such depositions is pursued in chapter 2. Deterioration in the state of a complete vessel from this type of grave is theoretically due to natural activity of the soil, to collapse of chamber or coffin or to careless excavation.

Glass from cremation graves has played a minor part in existing studies for the reason that the mutilated fragments were often not susceptible to any form of typological analysis. Here they will be used as a large and important part of the corpus. The ritual of the cremation ceremony is an essential factor to be considered. It is usually agreed, from archaeological and literary evidence, that in the majority of instances the funeral pyre was constructed in a location away from the ultimate position of the grave ⁽⁶⁾. We have, therefore, a two-fold sequence of events. The first involves the burning of the corpse together with the grave goods and the second involves the collection and burial of

these remains either in whole or in part. This is by no means a universal rite. Evidence exists from several Scandinavian cremations showing that complete objects were sometimes added separately to the burial rather than to the initial pyre (7). This is also pursued in chapter 2. There is no guarantee that all the residual glass from the pyre was transmitted to the grave, nor is the absence of glass in the cremation grave indicative of the absence of glass on the pyre. To be realistic we have little idea of the scope and distribution of glass remains in periods when the practice of cremation was commonplace. Even the position of the vessel in relation to the heat of the pyre may have had some bearing on the conditions of the remains at burial. The temperature at which glass melts has been used in the study of associated cremation remains, notably the bones themselves, but rarely has the corollary been considered useful (8). Many of these remains reach us as indeterminable shapes of distorted matter, devoid of form, traces of ornament, and often without clear indication of colour. Conversely some remains are only broken and twisted as a result of the heat.

Glass from culture layers is not usually discovered in forms susceptible to complete restoration, and we can divide the fragments into three broad types (9).

- 1) Fragments of vessels caused by domestic breakage, whether found in living areas, work areas, pits or chance finds.
- 2) Fragments caused by the destruction of buildings.
- 3) Fragments which reached the area of discovery in that form for the purpose of re-manufacture into other items, i.e. beads.

Vessels in domestic use are subject to further investigations concerning

the function of particular vessels, their availability, and not least their significance socially. It seems unlikely that glass vessels could have had a long life owing to the very fragile nature of the metal and to the conditions of habitation in which they must have been used. Vessels from occupation layers are discussed in detail in chapter 3. Vessels which do not coincide with normally accepted chronological limitations of type may perhaps be exceptional but are most probably due to faults in method of approach to the subject.

Fragments in destruction layers are theoretically from vessels which were complete at the time of destruction, unless we are to assume that fragments were stored within a building for some special purpose. As the most common form of destruction was by fire we may expect these fragments to be distorted as well as scattered. Destroyed buildings were often re-used, or at least the same site was re-used. In this case debris may have been removed and the fragments dispersed, and thus at the time of discovery these fragments would fall into category I.

Fragments brought to the site of discovery for the purpose of re-manufacture into other items are perhaps the most difficult to identify. We must assume that the site in question bears at least some relation to an existing trade route, and that the manufacture of other glass items by the secondary process is in some way apparent. It is also essential that necessary tools and requirements for this process are evident. The relationship and significance of the types of buildings in which these fragments occur is also a matter for discussion. Fragments found in a sunken hut in Valleberga, Sweden seem to be in an unusual or inappropriate context. Glass from that period is rare in Scania and as a luxury item is

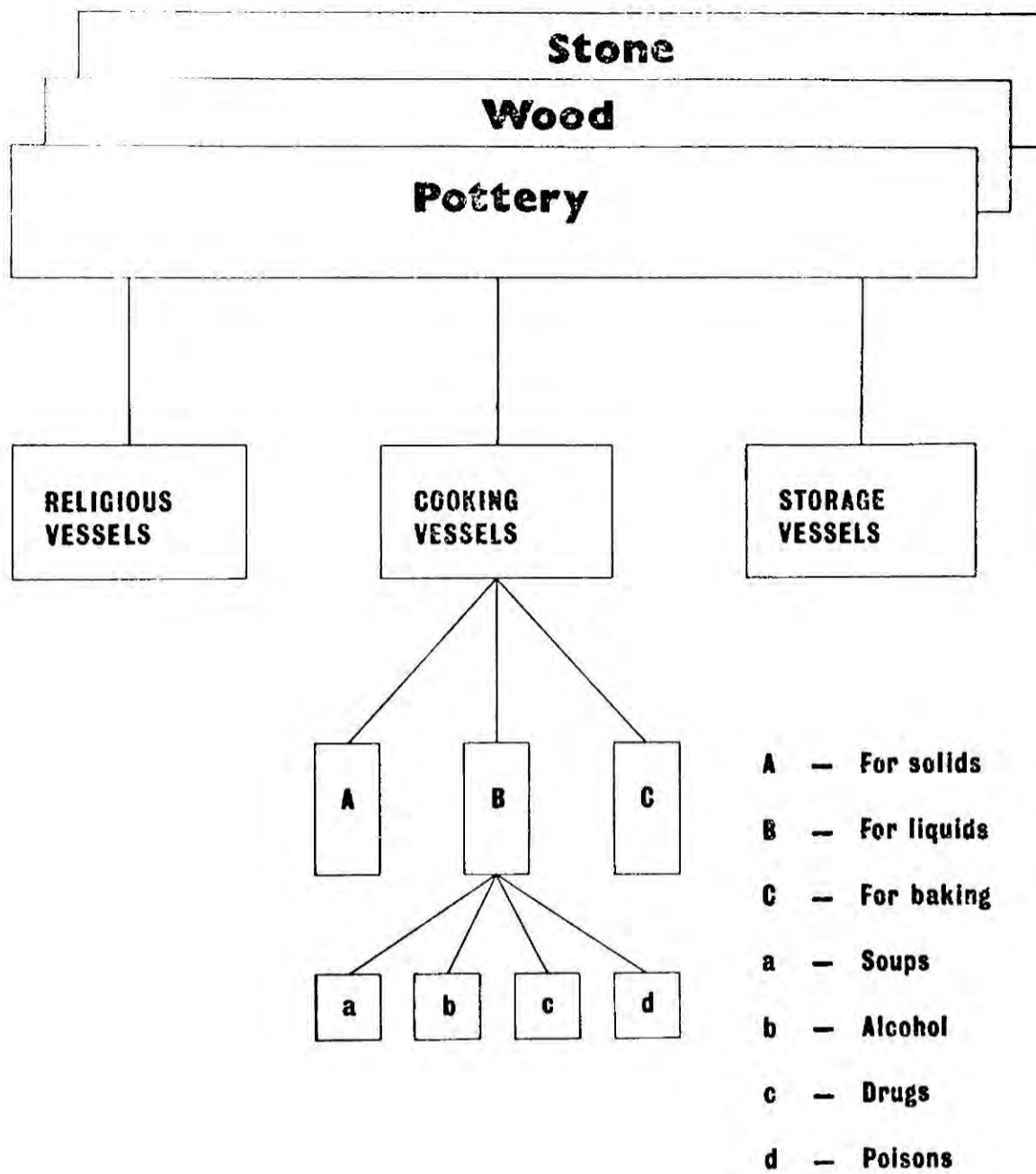
anomalous in a structure of this kind ⁽¹⁰⁾. The area of discovery has been associated with trade routes from the continent to the Mälaren region, and therefore a certain possibility exists for the access of either complete vessels or quantities of fragments. These sunken houses at Valleberga also contained evidence of metal working as well as yielding fragments of glass rods and a selection of beads ⁽¹¹⁾.

At Dinas Powys in Wales similar glass fragments were discovered, and it was suggested that they were imported in that condition for the specific purpose of re-manufacture ⁽¹²⁾. Evidence of other imported goods and indications of metal-working were similarly represented. The problem of the material from Helgö has also brought about the tentative suggestions that fragments were imported in large quantities ⁽¹³⁾. Metal working is also evident at Helgö and although the rich finds in the area would suggest the importation of whole vessels, the sheer quantity of fragmentary remains within the context of relatively few structures is surprising. Although the culture layers in which the fragments were discovered are said to span several centuries the number of fragments is still remarkable and on present evidence not one vessel could be restored to anything approaching complete form. Unless evidence can be found to state otherwise one is obliged to assume that these fragments existed initially on the site as complete vessels ⁽¹⁴⁾. Against this the production of a find frequency chart showed that in the main all the glass fragments were centred around one particular group of structures ⁽¹⁵⁾. This in itself suggests either a central store or place of manufacture. The area of density coincides with the distribution of imported objects on the site and places a correlation between the two groups of material. However it still fails to answer the question concerning the importation of either complete or fragmentary items in the first instance.

If the importation of vessel fragments could ever be proved by some positive means another problem emerges. Evidence for re-manufacture has hitherto been inconclusive, and thus the method of approach to glass studies has always been orientated on the assumption that excavated fragments were at one time part of a complete vessel near the location of discovery. The appearance of an incomplete item in the first instance needs a different approach and requires initial discussion in terms of function rather than in terms of form and decoration, both of which to a certain extent become irrelevant. Again the importance of a thorough insight into the problems of the background and origin of the vessels cannot be over-stressed.

Classification

A method for tabulating types of background information was devised by Vossen in a study of classification systems in American archaeology (16). He defined the two main systems in use, the analytic and the synthetic. The former is useful here and is illustrated in its general form in fig. I. An application of this model with regard to glass is produced in fig. 2. At the initial stage the basic material is divided into five groups each defined in terms of function. All these groups represent types of glass, or conditions of glass remains at the time of manufacture or at the time of importation. As we are concerned with the use and distribution of glass within Scandinavian contexts the material can only be considered in its state at the time of any importation and not in terms of a different state prior to importation. The uses to which I have ascribed them are out-lined only in the most general terms and do not take into account in any way whatsoever man's inventiveness or ingenuity in re-using existing articles to supply his own needs. The five groups

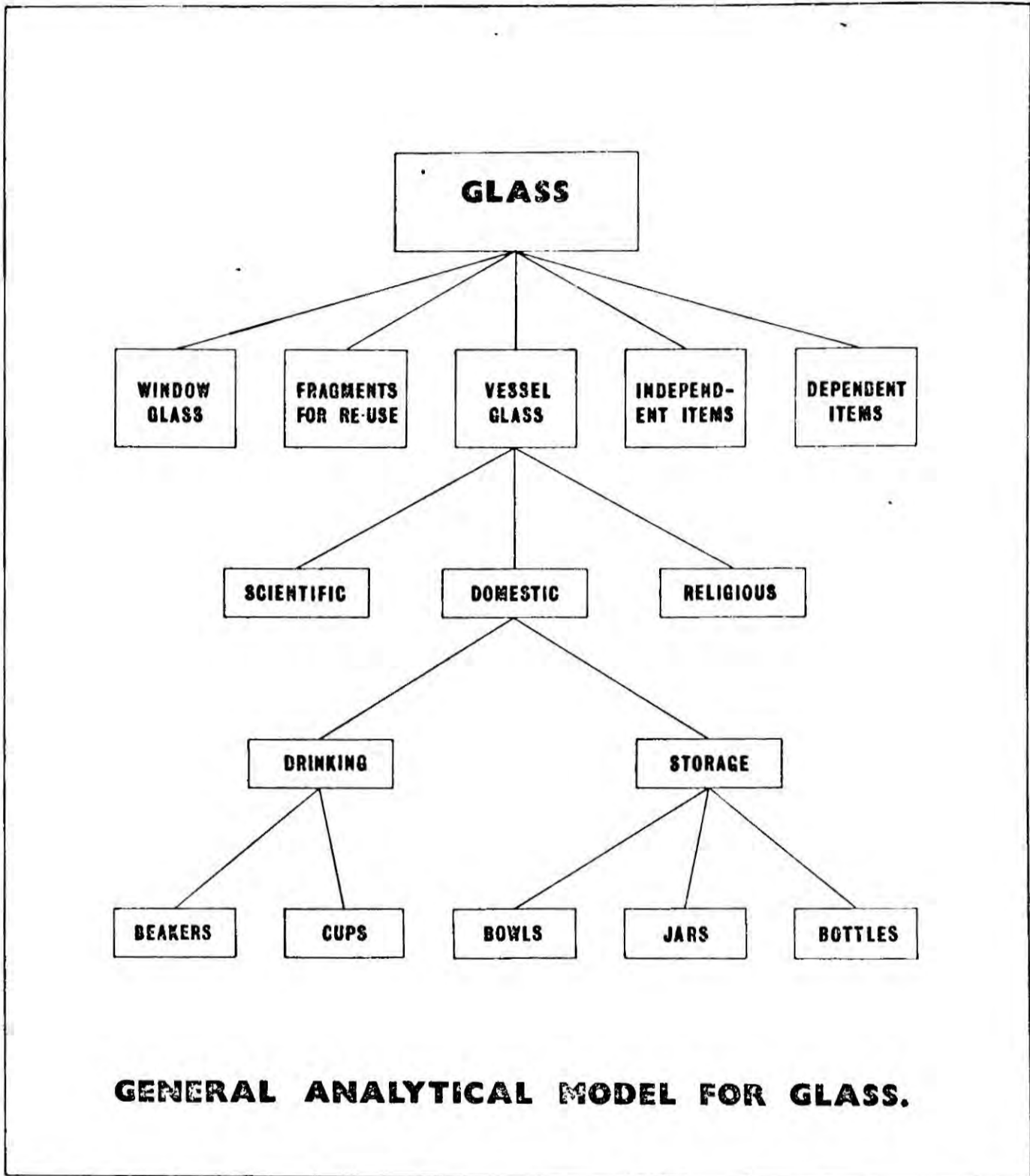


ANALYTICAL MODEL (AFTER VOSSEN 1970).

consist of window glass, glass fragments for re-use, vessels, independent glass objects such as lamps and statuettes and dependant glass items such as glass ornamental mounts.

The corpus of material is almost totally concerned with vessel glass in one form or another. The four other groups play a lesser role and I have not expanded them further here. The vessels can be subdivided in terms of usage under the headings "scientific", "domestic" and "religious". This is a more simplified terminology than might be desired but the scope is limited by the evidence available for the period. "Scientific" usage includes any vessel which may have a medicinal or even surgical purpose as well as those which are more strictly associated with early technology. Admittedly, there is little evidence for either but one cannot dismiss glass objects such as that from Varpelev, Denmark (183) as being merely an unexplained oddity. Glass vessels in a medical context are not unknown from our period in Britain, although the evidence becomes much stronger during the mediaeval period (17). As far as "domestic" vessels are concerned types of use and function are restricted to scanty evidence from illuminated manuscripts (18). The word "domestic" may have greatly different connotations of daily use and circumstances of use than those we might consider appropriate today. If the stories of the great halls and the mead-drinking have any truth then a single vessel would pass through a great many hands. In the absence of other evidence we must assume that domestic vessels were those required for table or personal use. A religious context is again barely supported, especially in lands where Christianity was late in arriving. One fragment at least can be cited, namely the blue vessel fragment from Helgö, Sweden (613) to which was attributed a

FIG 2.



certain Christian significance⁽¹⁹⁾.

A further sub-division of the domestic group produces two categories dividing vessels for drinking and vessels for storage. The former consists of beakers and cups while the latter contains the bowls, jars and bottles. I have differentiated beakers and cups in the catalogue using the criterion of proportion. Cups are thus defined as being those vessels with a height:diameter of rim ratio of less than 1.0. Where this ratio is greater than 1.0 the vessel is defined as a beaker. Beakers and cups were presumably both used for drinking. The fact that they are proportionally different and had different volumes would infer that they had a slightly different function. Exactly what that difference was we have no idea, but they are nevertheless recorded separately. The storage category contains two types of storage vessel. The first is represented by the open bowls which could not have contained liquids for long periods without evaporation. They must have been used for containing foods or liquids on a table for short-term consumption. Jars and bottles were for longer-term storage perhaps with stoppers or caps of a different material. The fact that the bowls are usually highly decorated tends to suggest that they were to be seen, while the jars and bottles were kept in store rooms. This does not preclude other uses for the vessels such as finger bowls or storage for perfumes and spices.

Glass tends to survive in the earth to a much greater extent than many other materials. There is every reason to suggest that items which may have been directly associated with glass vessels have not survived, or at least have not been recognised. The majority of the glass beakers which appear after ca. AD 400 are unstable in form and are clearly not vessels which could be stood upright on a surface. No wooden or metal

stands have been found and related to this problem although it seems more than likely that such items would have been in use either on a table or in a store-room to keep the vessels intact when not in use. The same applies to forms of bung or stopper, possibly of wood, which would have been needed for storage vessels to prevent evaporation.

The Social Environment

Together with this background information we must include factors involving availability and supply. It is just as important to statistically examine settlements and graves which did not yield glass as it is to examine those which did. The value of positive evidence can only be set in the correct perspective if compared to the negative evidence. Ideally all the glass finds from a given period should be mapped against all known settlements from the same period. There are numerous factors which should be introduced here. We must assume that the quantity of glass in an area depends on several fluctuating circumstances involving the cost of the item, the proximity of trade lines and possibility of commerce, the usefulness of the wares, the social status of glass as a commodity and the frequency of breakage. If the cost of a glass item is high either in real money or in goods then it is unlikely to be found in the poorer areas. Areas are usually classed as rich or poor to the extent that the closed find groups in graves reflect either wealth or poverty although the accuracy of this has been questioned ⁽²⁰⁾. Associated finds must always be considered. The necessity for a close trade-route is self-evident. An item not made locally will require some form of commercial network however flimsy for circulation. If the item is made abroad then presumably only places near the major trade routes will have the opportunity for immediate purchase. Areas geographically isolated or

towns and settlements lying away from these major routes will receive the items later in time and probably in smaller quantities. It therefore seems important to compare glass density to the proximity of trade routes, as well as to note a slight chronological difference between vessels in major towns and those in more remote areas.

The usefulness of glass is difficult to establish. In less wealthy areas or settlements pottery would have sufficed for most needs being locally made. Glass requires a skilled production centre of no mean economic strength. In more wealthy circles the advantage can only have been aesthetic. A tableware which was more delicate and pleasing to the eye than the traditional pottery or wooden containers would be a considerable social asset. The social status of a glass vessel depends upon the availability and cost of items. It would seem natural that places in strategic commercial positions would have access to more glass and thus the commodity would become quite common and any social significance would disappear. Dr. Erik Nylén has suggested that on the island of Gotland which is well known for its pre-mediaeval commercial prosperity glass vessels were common-place and were within the means of most people⁽²¹⁾.

The frequency of breakage is a factor which would affect the demand for new items. There is, however, little evidence to indicate the life-span of a vessel. Presumably the thicker tougher wares would survive longer than the more fragile items and it may well be that "exported wares" were made deliberately tougher to survive transport. Certain remarkable Norwegian finds show indications of repair using a metal foil with datable ornamentation. This signifies that the vessels were worth repairing once broken. The vessel from Solberg, Norway (426) is a Roman import dated to the first or second century while the gold foil used to

repair it can be dated to the early fifth century (22). Another vessel, from Snartemo (425), shows a similar metal foil repair but here the time difference is smaller (23). A full list of repaired objects is given in chapter 2. Neither of the vessels are by any means common either inside or outside Scandinavia and they may both have been sufficiently valuable or costly to merit repairs which were not only functional but also artistic in their own right. The need for repair suggests that the vessels may have had heirloom or sentimental significance and could not be replaced by existing forms of the day.

Before any typology proper can be attempted all these functional and social factors should be taken into consideration. Any system of typological classification should reflect to the greatest degree possible an understanding of these background problems. Unless there is an acknowledgement of the human environment in which glass was used then any system of classification will only treat the subject in isolation.

CHAPTER ONE - REFERENCES AND NOTES

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- (8) Wells C. "A study of Cremation", Antiquity, XXXIV, 1960, pp.29-37.
- (9) I am indebted to Mrs. E. Thorvildsen from the National Museum, Copenhagen for showing me an almost completely restored Migration period vessel prior to publication. This vessel (034) was from a

culture layer and is of outstanding quality. Other fragments were found from the same layer but none could be restored to anything approaching complete form.

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- (17) The main source for this evidence is Leechdoms Wortcunning and Starcraft of Early England, ed. P.O. Cockayne, 1864-1866.

"For swelling or puffing up of the liver" . . .

"bind (salve) upon the sore, and at whiles draw with glass or horn", (II, xviii p.201).

Another reference suggests that for dimness of the eyes:

"Mingle together juice of (wood lettuce) . . .

wine and honey, lay them up in a glass ampulla; use when

need be . . .", (II xxxi 3, p.129).

Reference to the use of cupping glass appears on several occasions, notably II, xxii p.207 and II, xlvii p.263.

- (18) Illuminated manuscripts rarely portray glass vessels of this period although a good example of a funnel beaker in use can be seen in the Calendar (November) of the Wandelbert-Martyrologium, Vat. Reg. lat. 438.
- (19) Lundström A. Op. cit., 1970.
- (20) Ucko P. "Ethnography and archaeological interpretation of funerary remains", World Archaeology 1971, 3 (2) pp.262-280.
- (21) Nylén E. "En oskadad glasbägare bland nya rika fynd från Gotlands folkvandringstid och vendeltid", Gotländskt Arkiv, 1967 p 53 ff .
- (22) Shetelig H. Norges Forhistorie, Oslo 1925, Pl. 3.
- (23) Hougen B. "Snartemofunnene", Norske Oldfund, VII, 1935.

CHAPTER TWO - GLASS VESSELS IN BURIALS

The majority of Scandinavian artefacts dated to within the first millenium A.D. appear from the context of burials. Although discussion of these artefacts is usually centred around such broad topics as typology, trade or general levels of culture, remarkably little work has been attempted in detailed studies of the nature of the physical deposition of specific funerary items. This is all the more surprising considering that the artefacts used to interpret the daily life of an early society are derived almost totally from circumstances of death and not from the circumstances for which they were manufactured or in which they were most used. This is mainly because such a study requires a laborious collection of relevant regional and chronological data, and because there are few existing works on the subject to which the study could be suitably related. The aims here are to outline the problems involved in a discussion of glass vessels from funerary remains, and to illustrate the potential of the subject for future research.

The difficulties are two-fold. The first is concerned with the evaluation of the source material handed down by previous archaeologists and the second is concerned with interpreting the link between the world of the dead as shown in the burial and the world in which the dead existed. The first difficulty is not helped by the absence of written works concerning burial customs. This is especially apparent in Norway and Denmark. Norwegian literature on this subject consists of only one major work, by Shetelig in 1912 ⁽¹⁾. This lamentable position has recently been discussed in a paper by Rita-Naess ⁽²⁾. However, a more fundamental shortcoming is that much of the earlier excavated material is without record of critical archaeological information. A study of

the entries in the catalogue which is derived solely from published reports, and where available, excavation notes illustrates this problem. In the majority of burials there is insufficient recording of the nature and size of the burial monument, the stratification of a cremated layer, the orientation of the body or the position of the grave furnishings.

The second difficulty, concerning the link between the world of the dead and the world in which the dead existed, is one usually solved with the help of anthropology and ethnography. As early as 1877 Rygh wrote that "the more completely we can understand this link, and the more certain we are of its value, the better we will be able to protect ourselves from reaching the wrong conclusions concerning living conditions at the time of the burial"⁽³⁾.

A detailed study of the interpretation of funeral remains cannot be carried out here. The relevant anthropological and ethnographical backgrounds to the study are so great and so varied that it is only possible to outline the general approaches and problems. Funerary remains are usually discussed with regard to four factors; the variation of the burial theme, the concept of the afterworld, comparative wealth and poverty and the significance of the grave goods. They are all interdependent. Archaeological evidence alone can build no more than a superficial picture strengthened by ethnographic parallels. However, in the chronological periods under study there are fortunately several surviving literary works which either infer or describe concepts of death and give accounts of burial practices. The standard work used in this respect is the Old English poem "Beowulf". The description of the death of Scyld in which the chieftains body is sent out to sea equipped with all his

treasures is a scene which acknowledges the concept of a journey after death⁽⁴⁾. Nevertheless the rhetorical question asked by the poet, "Who can truly say who received that cargo?" infers that the splendour of the ritual was in the pageant of the ceremony rather than in the concept of a journey to a specific place⁽⁵⁾. The same problem appears in a much-discussed passage from the "Seafarer" where the poet laments his place in life and tells how his soul becomes restless and urges "that I may visit the distant lands of strange peoples"⁽⁶⁾. Such sources can only suggest the most general concepts of the afterlife, and taking into account the heroic traditions in which they were written are unlikely to be historically accurate. The Journey itself is common to all European mythology. There is little doubt that the funeral of Scyld was accurate in certain respects. The evidence of the richly furnished boat can be seen in burials such as those at Oseberg, Borre and Vendel but like their literary parallels they belong to chieftains, heroes or even royalty and therefore the circumstances are special rather than typical. Nevertheless the presence of stone settings around graves in the shape of a ship are known in Sweden from as early as the late Bronze Age.

Additional archaeological and literary evidence shows that this was only one of the many burial customs practised. Another funeral, this time of Beowulf himself, is of equal interest. Here the body was to be burnt and laid upon "a splendid pyre hung about with helmets, shields and shining corslets" all of which would presumably be consumed by the fire⁽⁷⁾. A vault was built around his ashes and additional treasure plundered from the dragon's lair placed within the barrow. Not only does this indicate the habit of placing uncremated grave goods in the

monument, but it also provides an archaeological warning in that these later offerings were described as "ancient" at the time of the burial. The dating of a burial is therefore made more arduous. The same problem arises with the presence of "heirloom" objects the dating of which has little relevance to the date of the burial.

The custom of cremation is perhaps best explained in the account of the Arabic traveller Ibn Fadlan who described a Norse funeral on his visit to the Volga in AD 922⁽⁸⁾. He was informed that the reason for cremation was in order to allow the deceased to journey to paradise as quickly as possible rather than to be eaten by worms in the ground. This particular funeral was for a chieftain but there is no mention of tangible signs of wealth placed alongside the body before or after cremation.

Many of the references relating to burials comment specifically on the insertion of precious objects within the grave. In many cases the tradition of the literature uses the word "gold" to denote objects of value. In the "Seafarer" the poet tells that "A man may bury his brother with the dead and strew his grave with golden things . . ." ⁽⁹⁾. A passage in "Beowulf" is more cynical mentioning that the gold buried in the mound was "as useless to man as it was before" ⁽¹⁰⁾. This comment introduces the problems of interpreting the choice of goods and the reasons for placing them there. Professor Piggott commented that all tomb offerings were bound to have been socially selected according to criteria that remain unknown today ⁽¹¹⁾. He also pointed out that grave goods in no way represented a random sample. The practice of inserting objects and tools from daily use is almost universal throughout Scandinavia, although their relevance to the known mythology is sometimes

obscure. Closed find groups from inhumation burials may only represent a display of worldly wealth at death or in the next world. Many burials, notably those from Birka, Sweden contain evidence for the occupation of the deceased such as a pair of scales or a set of smith's tools. In many cases the furnishings are positioned in the grave in groups each of which has its own particular significance. These groupings often contain assemblages of arms, personal ornaments and valuables or utensils and tools and are presumably particular to the person concerned rather than general to all burials.

Determination of comparative wealth from these remains has been the focus of much discussion. Ucko has pointed out that according to ethnographic parallels the identification of rich and poor members of the same society from funerary remains is not as simple as archaeologists have believed it to be⁽¹²⁾. On a more general cultural level, a paucity of grave goods does not necessarily imply a low level of material wealth. In the study of a prehistoric society it would be dangerous to argue comparative wealth or poverty without an understanding of the anthropological background and a knowledge of ethnographic parallels. However, in a proto-historic or historic time there is less need for this. Other factors such as literary evidence and known trade routes can assist. The task here is to determine the significance of glass in burials and this is a task which can best be carried out by accurate determination of positions, types of vessel and comparative regional and chronological surveys. The basic difficulty is unfortunately in assessing the value of source material, much of which lacks the vital archaeological information.

Some mention should be made of the burial type itself. The varied distribution of types throughout Scandinavia is usually explained as being due to the presence of different cultural groups. However, a study of Norway where habitable land has always been limited shows that different practices took place in the same areas and at the same time. This has been the subject of much discussion centering on the argument as to whether culture change through immigration was represented by concepts rather than by artefacts⁽¹³⁾. Traditionally burial customs have been used to identify different groups of people on the assumption that burial practices are the kind of traits which can be treated as being diagnostic of different cultures. This in turn infers some form of cultural contact. In the chronological periods under discussion here this contact is known to a great extent from documentary evidence and is supported by archaeological findings. Consequently, in the study of glass in Scandinavia the best method of approach is by an examination of the material remains, firstly in relation to the basic burial customs and secondly by the study of the significance of the grave furnishings. By reconstructing the activities prior to death it is possible to show the relevance of the glass vessel within those activities.

An examination of the catalogue shows that it is impossible to associate certain types of burial custom or monument with specific types of glass. Firstly the information available is incomplete and secondly the burial practices and monuments vary considerably both regionally and chronologically. All the evidence points to glass as being a relatively common artefact in both cremation and inhumation graves in

all periods. An ideal study would be to examine burials of all types and of all periods regardless of the presence of glass in an attempt to produce a statistical survey of the use of glass in burials. Such a task is impracticable in this study. The regional distribution of glass from burials is listed below (Table A) together with the chronological distribution for both cremations and inhumations (Table B and Table C respectively).

Table A - Geographical Distribution

<u>Location</u>	<u>Glass from Cremations</u>	<u>Glass from Inhumations</u>
Bornholm	14	3
Denmark	66	91
Gotland	82	18
Norway	31	68
Sweden	158	52
Öland	8	3
	<u>359</u>	<u>235</u>

Table B - Chronological Distribution for Cremations

<u>Location</u>	<u>Roman</u>	<u>Migration</u>	<u>Vendel</u>	<u>Viking</u>	<u>Undated</u>
Bornholm	13	1	-	-	-
Denmark	66	-	-	-	-
Gotland	15	31	27	-	9
Norway	10	16	1	4	-
Sweden	23	29	41	43	22
Öland	1	4	1	-	2

Table C - Chronological Distribution for Inhumations

<u>Location</u>	<u>Roman</u>	<u>Migration</u>	<u>Vendel</u>	<u>Viking</u>	<u>Undated</u>
Bornholm	2	1	-	-	-
Denmark	83	5	-	3	-
Gotland	5	8	4	1	-
Norway	25	36	1	5	1
Sweden	8	3	8	33	-
Öland	3	-	-	-	-

The nature of the burial monument bears little relation to the finds within the burial itself, at least as far as the available evidence suggests. Some different types of burial monument seem to be localised, although the majority throughout Scandinavia from all periods take the form of some type of mound. The Danish finds which are predominantly Roman or early Migration contain a noticeable proportion of urn burials few of which are covered by mounds. The best example of this type is the vast gravefield at Møllegaardsmarken, Denmark. Mound burials are usually described in terms of their height and diameter and this practice has been followed wherever possible in the catalogue. However, bearing in mind the possibilities of natural erosion or ploughing these measurements may have little value. Some mounds are strikingly different by way of their size such as the huge mounds at the Valsgårde gravefield (Gamla Upsala parish, Sweden) and the "Kings Mound" in the same parish. Through their magnitude and wealth of grave furnishings one must assume them to be memorials to socially superior individuals. In only one instance in the catalogue is there evidence of an additional type of grave marker. This is above the cremation burial at Husby, Sweden (646) where the burial mound is surmounted by a small stone cairn. Gotland provides the greatest

variety in type of burial monument. In several instances the mound is surrounded by a setting of stones either in the shape of a circle (222, 250), a square (232, 252) or a rectangle (236, 248). Gotlands burial types are notoriously idiosyncratic and bear little similarity to the plainer monuments in the rest of Scandinavia. The same applies to the small stone cists which enclose many of the Gotlandic cremation layers.

Cremation burials themselves contain some interesting features relevant both to the study of cremation practice and to the significance of the glass vessels. Several burials containing burnt human bone and burnt offerings yielded complete glass vessels. These are listed below:

<u>Cat. No.</u>	<u>Location</u>	<u>Date</u>
122	Denmark	Roman
327	Norway	Migration
336	Norway	Roman
639	Sweden	Roman
701/2	Sweden	Roman
767	Sweden	Roman

Complete vessels from cremation burials can hardly have been subjected to the intense heat of a funeral pyre. Their placing in a cremation layer must signify a deposition after the burning. The example from Møllegaardsmarken, Denmark (122) indicates that the practice was not a casual afterthought but a specific and deliberate action. Here the glass cup was placed among the cremated ashes within the funeral urn. It would be unwise to deduce from these six examples that glass was in some way a special artefact or had a particular significance to warrant this treatment. Unfortunately no studies have been undertaken with

regard to the use of other artefacts in this respect and it is not therefore possible to draw an accurate conclusion. However, the pair of finely incised glass beakers from Skivarp, Sweden (701/2) found in a cremation layer suggest that such high quality items, presumably purchased and buried in pairs, may have held a special significance. The presence of pairs and sets of vessels in inhumation burials is discussed below. Further support for the argument is given by the presence of a glass drinking horn from a cremation from Stangeland, Norway (429). Here the vessel is incomplete, the centre portion being missing. It is likely that the horn was laid in the cremation layer in two parts perhaps indicating that even the incomplete vessel was of some special significance and an appropriate tribute. There is insufficient evidence to interpret accurately, but nevertheless the presence of the glass vessel in these circumstances is worthy of comment.

Glass can best be studied in the closed find groups from inhumation burials. Cremation burials cannot be used accurately for the reasons that the grave goods within them are not necessarily totally representative of the offerings laid on the funeral pyre with the deceased. As there are clearly numerous variants of the cremation practice it is almost impossible to use the furnishings with any degree of consistency. Inhumation burials on the other hand generally provide a valuable closed find group representing items and their relative positions at the time of interment of the body. The problem here is that the excavation of many such burials, particularly those undertaken in the nineteenth or early twentieth centuries failed to record the position of the many

artefacts and in several instances may have failed to manage a total retrieval of the fragmentary item.

In Scandinavia there are 187 unambiguous inhumation burials containing glass vessels in one form or another. Dubious or robbed inhumations are not included, nor are burials which show the slightest evidence of burnt bones or charred offerings. This total of burials yielded 148 complete vessels and 87 incomplete vessels, giving a minimum number of 235 individual glasses. 36 burials contained more than one vessel. They can be listed in the order of the catalogue in the following manner:

	<u>No. of inhumations</u>	<u>Complete glasses</u>	<u>Incomplete glasses</u>
Bornholm	3	3	0
Denmark	62	66	25
Gotland	19	8	10
Norway	59	39	29
Sweden	42	31	21
Öland	<u>2</u>	<u>1</u>	<u>2</u>
	187	148	87

A striking fact emerges from this table, namely that the number of incomplete glasses is approximately one third of the overall total. It is often assumed that in the great majority of burials of this kind the glass vessel was buried intact and is therefore theoretically retrievable in its entirety, even when broken. This is clearly not the case and seems to indicate a custom of placing glass fragments within the grave group, a fact which in turn may reflect the value of such items in daily life. The accuracy of this part of the study is dependent

upon the validity of the written sources used, the circumstances of discovery and the recording of excavation procedure. This practice of source criticism may illustrate only too well the dangers of accepting the value of written material and even physically displayed material in museums. The problems are particularly apparent with the use of material discovered in the late nineteenth or early twentieth centuries where methods of retrieval, recording and conservation were in many ways different to those applied today.

A study of the material shows that the incomplete items can be grouped into two main classes, those which have a small part of the vessel missing and are relatively complete and those which only occur as apparently isolated fragments often from indeterminable types of vessel. A relatively complete vessel may occur through difficulty in reconstructing fragments of a damaged vessel, necessitating gaps in the fabric and resulting in an incomplete object in the museum. Unfortunately few excavation reports comment on whether a fragmentary vessel was discovered 'in toto' or whether the incompleteness occurred after reconstruction. Another factor exists here, namely that a slightly damaged or broken vessel may have been placed in the grave group on the assumption that it was sufficiently whole to represent a complete vessel. Here it may be possible to assume that glass was a relatively rare commodity and that this act was a fitting gesture. There is little evidence from other artefacts that discarded objects or even refuse was placed in burials and any theory that these fragments represent unwanted waste is discounted below by an examination of their positions and contexts in comparison to those of complete vessels. This fragmentary

material can be divided into two groups A and B denoting almost complete vessels and fragments respectively. This is not such a subjective procedure as it may appear, and the majority of the eighty-seven examples fall clearly into the two groups. These are listed below together with the general dating of the burial and the date at which the finds are first recorded.

Group A - Vessels which are almost complete

	<u>Cat. No.</u>	<u>Date of Burial</u>	<u>First Recorded Date</u>
<u>Denmark</u>	144	Roman	1875
<u>Norway</u>	314	Migration	1889
	315	Roman	1946
	320	Roman	1930
	330	Migration	1887
	338	Migration	1871
	392	Migration	1938
	396	Roman	1902
	403	Migration	1882
	424	Migration	1878
	437	Migration	1876
<u>Sweden</u>	474	Roman	1956
	521	Viking	1937
	744	Vendel	1927
<u>Öland</u>	769/70	Roman	1965

Group B - Fragments of vessels

	<u>Cat. No.</u>	<u>Date of Burial</u>	<u>First Recorded Date</u>
	026	Roman	1951
	035	Viking	1937
	041	Roman	1951
	044	Roman	1956
	058	Viking	1881
	060	Roman	1951
	062/3	Roman	1871
	068	Roman	1911
	069	Viking	1875
	147	Roman	1877
	153	Roman	1871
	154	Roman	1872

	<u>Cat. No.</u>	<u>Date of Burial</u>	<u>First Recorded Date</u>
	162	Roman	1952
	167/8/9	Roman	1871
	173/4	Roman	1873
	177/8	Roman	1871
	179	Roman	1877
	185	Roman	1871
	187	Roman	1951
Gotland	230	Viking	1930
	256	Vendel	1902
	258	Migration	1883
	260	Migration	1935
	269	Roman	1907
	281	Vendel	1908
	294	Roman	1896
	295	Migration	1896
	296	Migration	1885
	297	Roman	1923
Norway	304	Migration	1875
	305	Viking	1906
	309	Viking	1887
	310	Roman	1911
	326	Migration	1887
	390	Roman	1929
	391	Migration	1915
	397	Migration	1960
	401/2	Migration	1920
	405	Migration	1938
	410	Migration	1912
	417	Roman	1896
	419	Roman	1920
	420	Viking	1968
	436	Roman	1917
	445	Roman	1886
	450	Roman	1871
	452	Migration	1878
Sweden	508/9/10	Viking	1937
	513	Viking	1943
	517	Viking	1943
	518	Viking	1937
	525/6	Viking	1937
	527	Viking	1937
	528	Viking	1937
	529	Viking	1937
	624	Migration	1936
	746/7/8	Vendel	1927
	753	Roman	1955
	755	Migration	1973
	765	Roman	1938

An initial glance at these tables shows the relative proportions to be sixteen examples of almost complete vessels and seventy-one fragmentary vessels. It can also be seen from the general dating of the items that there is no immediately significant relation to chronological periods apart from a large proportion of almost complete vessels from Norway. These Norwegian finds all date to the Roman or Migration periods and this is pursued below. The list of dates showing the first recorded evidence of the finds indicates the antiquity of some of the earlier excavations. Many of them date to the late nineteenth or early twentieth century and this is slightly disconcerting although it should be remembered that these early dates are very common throughout the entire corpus and relate to both complete and incomplete vessels. Many of the other early recordings, particularly those from the nineteenth century appear only in lists of various finds from given areas. In these cases the method of excavation is not recorded and much useful detail is absent. Any conclusions based upon these tables should bear these factors in mind and any interpretations should be made in awareness of the limited evidence available. It is unfortunately not possible to draw a clear line between reliable and suspect information from these sources.

In the first group all the vessels are of clearly defined types usually with specific decorative qualities. Some items in particular are only damaged in a minor way and were possibly placed among the burial goods as symbolically representing a complete vessel in a particular concept of the next world. Four of these are from Norway, from Hibnes (330) where the foot of the vessel is missing, from Naerland (403) where part of the rim has gone, from Snartemo (424) where part of

the side is missing and from Høien (338) where the mouthpiece of a drinking horn is absent. The others are from Sweden, from Badelunda (474) where the vessel lacks part of the rim and body, from Birka (521) where part of the body is missing and from Bredsätre, Öland (769,770) where parts of the bodies of a pair of bowls are missing. A useful parallel could perhaps be the shield from the ship burial at Sutton Hoo, England which had been repaired and was no longer servicable but which was sufficient for the purpose of the burial. One could argue that the conditions of all these vessels were due to poor retrieval. However, the excavations at Badelunda and Bredsätre are comparatively recent (1956 and 1965 respectively) and both excavators are quite emphatic that the vessels were incomplete at the time of discovery.

All the other vessels in this group are somewhat less complete but are nevertheless sufficiently whole to determine type of vessel and decoration. They include a "cased" beaker (314), a bowl with marvered decoration (315) and a large bowl with folded rim (396). There are three beakers showing ground oval decoration (320,392 and 437). The remaining two consist of a beaker with applied coloured trails (144) and a claw beaker (744). Even allowing for a certain percentage of vessels whose conditions may be due wholly to bad retrieval the existence of these fifteen examples suggests that a practice was followed in which incomplete vessels of recognisable form and decoration were placed in burials. This incompleteness infers that despite their condition they were of some significance and this is a fact which in itself indicates a high value factor in daily life for reasons of either shortage or cost. The predominance of this type of vessel in Norway is no accident and can be

compared to the distribution of repaired vessels examined below.

The second group of incomplete vessels from inhumation burials relates to the very fragmentary items. Few of these allow the type of vessel to be determined. However, in many instances the type of decoration is apparent, and the total of seventy-one items can be divided into two groups, the first consisting of fragments which show decoration (fifty-four examples) and the second consisting of 'simple' fragments with no decorative qualities available (seventeen examples). Both are of interest in that the placing of fragmentary material within a burial may be representative of some symbolic gesture.

In the group of fragments which exhibit decoration are fragments of moulded "lotus" bowls from Bodum, Denmark (026) and Vrangstrup, Denmark (187) as well as fragments of a bowl from Sanderumgård, Denmark (154). The bowl form itself is not common and its presence in fragmentary form may be significant. Other forms which predominate are the straight-sided cup, often with painted animal ornamentation such as those from Torslunde, Denmark (167,168,169), Varpelev, Denmark, 176,177, 178) and a single painted fragment from Stenlille, Denmark (162). Fragments of cups with ribbed feet appear four times (041,390,445,753). The most common decorative themes found in this group of fragments are those of incised or ground decoration and applied trails. Undecorated fragments of funnel beakers appear on four occasions (035,420,513,525/6). These vessels rarely show any decoration but their form is characteristic and there is little difficulty in placing them.

The claw beaker appears in four instances (281,305,309,747/8)

although here it is difficult to determine the form of the claw beaker from the evidence available. In the example from Roma, Gotland (281) only the base fragments remain while in the examples from Vendel, Sweden (747,748) fragments appear from all parts of the vessel yet do not allow reconstruction. In this instance one wonders exactly how or why vessels could be interred in that condition. Apart from incomplete retrieval the only possibility can be that the majority of fragments of a broken vessel were collected and symbolically used in the burial. The same must apply to fragments of a cup from Vendel, Sweden (746) which consisted of the rim portion and the base, but not the body between. This must have been placed in the grave in two separate pieces. The remaining fragments in this group consist of the remains of three "cased" vessels (269,410,419) and the fragment from the top of a flask (230).

The remaining group of fragments (B), which bear no traces of decoration are more difficult to justify in a burial context. It is credible that almost complete vessels were placed in graves, or for that matter that part of a vessel with a particular decorative characteristic could have been used symbolically, but it is hard to believe that plain undecorated fragments should have been considered fitting tributes to accompany the dead. Nevertheless, this practice occurred and examples such as the fragment from Haraldstedpladsen, Denmark (044), excavated and published by Norling-Christensen in 1956 who commented specifically on this phenomenon, show that dubious excavation cannot always be held responsible.

One can only assume from this long list that glass was in some respects a special artefact. A possible reason for this is perhaps that glass was a highly-prized commodity and that its presence either in complete or token form in the burial reflected the comparative wealth of the deceased before death. This is reflected in other ways in a study of the actual positions of the vessels within the burial. In many instances even with complete vessels there is no information regarding the position of the glass in relation to the skeleton. Those which are recorded often indicate that deliberate care was taken in placing the glass. Two Norwegian examples illustrate this. The fragments from Føyna (320) were specially positioned in a small depression in the ground next to the body, and fragments from Tanum (436) were carefully set inside a pottery vessel. The majority of the other fragments whose positions are recorded appear near the head of the body, a place usually reserved for personal or valuable goods. This supplementary evidence gives little doubt that glass was a special and prized commodity.

The concept of glass being a wealth or status artefact can be expanded in an examination of a group of vessels which show indications of repair. All these examples appear from burials in Norway and date to the Roman or Migration periods. The best known example is perhaps that from Solberg (426). The circumstances of this find are not recorded, but the fragments which are of an opaque vessel with "cameo" decoration and have been repaired with gold foil depicting animal ornamentation of the early fifth century. A vessel from Snartemo (425) had been repaired in a similar way with a metal strip riveted around the rim.

This showed a later form of animal ornamentation dated to the early sixth century. A bowl from Hogstad (331) used a similar method of repair and has a metal band attached around the girth of the vessel suitably stamped with fifth century animal decoration. Greater repairs were needed on a beaker from Øvsthus (457) which was fitted with a bronze strip around the rim and a large bronze plate inside. This illustrates the extent to which repair work was carried out, for although the vessel may have become servicable again, it would have almost certainly ceased to have been pleasing to the eye. The final example of these vessels is from Kvasheim (392) where part of the base area had been patched with a plain metal strip. These types of repairs indicate that the restoration of glass vessels was worthwhile and necessary and this in turn indicates that glass itself was valuable or hard to obtain.

The position of Norway with regard to this concept of value becomes continually more significant. It has already been shown above that the great majority of almost complete vessels from inhumation burials appear in Norwegian graves and are dated to the Roman and Migration periods. The distribution of repaired vessels which occur only in Norway are all of similar date. This can be no coincidence and may reflect a scarcity of glass in Norway at that time. Against this theory one must mention Bakka's article relating to trade patterns in Scandinavia⁽¹⁴⁾. His plotting of the "Snartemo" type of beaker which is common in Norway up until about AD 600 shows a distribution centred around two specific areas, Norway and Gotland. This distribution in Norway conflicts with a theory of glass shortage but Bakka's reasons for this distribution can be used

to explain the anomaly. He cites the distribution as being probably due to differences in burial practice between these two areas and the rest of Scandinavia, rather than to an accurate distribution representing trade patterns. During the fourth, fifth and sixth centuries Norway practiced rich burial customs with some outstanding burials furnished with arms, ornaments and weapons. Much of the rest of Scandinavia at this time followed a simpler practice in which the richly furnished grave was less common. It cannot be argued that the rest of Scandinavia was poorer than Norway for it yielded the majority of the great Migration period gold hoards. The wealth was clearly available but not manifest in burials. Consequently it is necessary to review the Norwegian material within a Norwegian rather than a Scandinavian context at this time. By doing this it is still clear that fragmentary and repaired glass vessels were held in high esteem for burial purposes, a factor which in turn signifies their importance in daily life.

In ascertaining the value or importance of glass vessels it is worthwhile to examine vessels which appear in groups or sets within the same burial. Here a group is defined as being two or more dissimilar types of vessel within the same grave and a set as being two or more similar vessels within the same grave. The catalogue shows a total of thirty six inhumation burials which contain the remains of more than one vessel. In terms of their distribution twenty are from Denmark, nine from Norway, six from Sweden and one from Öland. Most of the burials contain at least one complete vessel and these are listed below. One column denotes the presence of groups of different vessels within the burial, one denotes definite similarity of form and decoration between

vessels and one column denotes possible similarity between vessels (e.g. where there is one complete vessel and fragments of another which in form and decoration is possibly similar to the first). The final column shows the proportion of complete vessels to the total number of vessels in the same burial.

	<u>Cat.No.</u>	<u>Date</u>	<u>Group</u>	<u>Definite</u> <u>Set</u>	<u>Possible</u> <u>Set</u>	<u>Ratio</u> <u>Complete:Total</u>
<u>Denmark</u>	027/8/9	Roman		X		3:3
	038/9	Roman		X		2:2
	047/8/9	Roman		X		3:3
	050/1	Roman	X			2:2
	053/4/5	Roman	X			3:3
	061/2/3	Roman			X	1:3
	065/6	Roman		X		2:2
	067/8	Roman			X	1:2
	072/3	Roman		X		2:2
	074/5	Roman	X			2:2
	141/2	Roman		X		2:2
	143/4	Roman			X	1:2
	156/7	Roman		X		2:2
	161/2	Roman		X		2:2
	167/8/9	Roman			X	0:3
	170/1/2	Roman		X		3:3
	173/4	Roman			X	0:2
	176/7/8	Roman			X	0:3
	180/1/2/3	Roman	X			4:4
184/5	Roman			X	1:2	
<u>Norway</u>	303/4	Migration			X	1:2
	329/40	Migration	X			1:2
	334/5	Viking	X			2:2
	401/5	Migration			X	0:2
	404/5	Migration			X	1:2
	408/9	Migration	X			2:2
	416/7	Roman			X	1:2
	418/9	Roman	X			1:2
	432/3	Roman		X		2:2
<u>Sweden</u>	508/9/10	Viking	X			0:3
	511/12	Viking		X		2:2
	525/6	Viking			X	0:2
	618/19/20	Viking	X			3:3
	698/9	Roman		X		2:2
	745/6/7/8	Vendel	X			1:4
<u>Öland</u>	769/70	Roman		X		0:2

This list shows that out of the thirty-six burials thirteen contain sets of similar vessels. Of these all are complete with the exception of the two bowls from Bredsätre, Öland (769,770). Ten of these burials contain pairs of vessels and three contain sets of three similar vessels. The pairs are interesting in that both the burials at Espe, Denmark (038,039) and Store-Dal, Norway (432,433) contain pairs of the same type of bowl. This may suggest that these bowls were bought and used in pairs for a specific function before burial. Both burials are dated to the early part of the Roman Iron Age and this coincides with the dates of the pair of glass bowls from Juellinge, Denmark (065,066) and the pair of glass cups from Stenlille, Denmark (161,162). This possibility is emphasised by the appearance of a pair of cups almost identical to those from Stenlille found in a cremation burial at Skivarp, Sweden (701,702) from the same period. The Skivarp vessels are complete and can hardly have been subjected to the heat of the funeral pyre. This again supports their value as artefacts and their significance as a pair.

Five burials produced vessels which were dissimilar only by way of slight discrepancy in size or decoration. Those slightly differing in size are the pair of painted cups from Nordrup, Denmark (141,142) and the pair of beakers decorated with applied coloured "snake" trails from Laebrogaard, Denmark (072,073). The pairs of vessels from Sigersted, Denmark (156,157) and Selånger, Sweden (698,699) differ slightly by way of decoration. The remaining pair from Birka, Sweden (511,512) consisting of a pair of funnel beakers differ to the extent that one (511) has a different coloured rim.

Burials which produced vessels in sets of three are those from Borritshoved, Denmark (027,028,029) containing three straight-sided cups, from Himlingøje, Denmark (053,054,055) containing three bowls and from Uggeløse, Denmark (170,171,172) containing three beakers of the "Snartemo" type. In each of these three burials all the vessels were complete and no two were of the same size within a set. All were proportionally identical but each set consisted of a large, medium and small vessel. In the case of the vessels from Borritshoved, all three were carefully laid out in decreasing order of height at the head of the deceased.

This number of burials containing sets of vessels may be increased by a study of those burials which contained possible sets of vessels. There are twelve such burials all of which contain a certain quantity of fragmentary material which could conceivably belong to a set. An example of this is the burial at Juellinge, Denmark which contained a complete beaker with faceted decoration (067). Also in the grave were fragments of a second vessel (068) which showed clear signs of faceted decoration. Similar instances occur at Nordrup, Denmark (143,144) where there is a complete beaker showing "snake" trail decoration together with fragments of a similar vessel. Other examples appear from Velsted Mølle, Denmark (184,185), Nordgården, Norway (404,405), Saestrang, Norway (416,417) and Blindheim, Norway (303,304). A burial from Højrup, Denmark (061,062,063) contained a complete vessel together with fragments of two possibly similar vessels. Five inhumation burials yielded no complete vessels, but only sets of fragments. These are from two vessels with "snake" trail decoration from Valløby, Denmark (173,174), fragments

of two incised vessels from Maele, Norway (401,402) and fragments of two funnel beakers from Birka, Sweden (525,526). The straight-sided cup, often showing painted decoration, and noted in the sets above, also appears in fragmentary form at Torslunde, Denmark (167,168,169) and Varpelev, Denmark (176,177,178). In both these burials all the glass was incomplete. However, there were sufficient fragments available to establish that in the Torslunde burial one vessel was painted (167) and that the other two were unpainted, while in the Varpelev burial all three cups were of slightly different size.

The remaining burials contain groups of different types of vessel. Two burials from Himlingøje, Denmark are good examples. One contained an incised cup and beaker (050,051) and the other an incised cup, beaker and horn (053,054,055). A further group containing a horn appeared at Laerkenfeldt, Denmark (074,075). The different types of vessel within the same burials can be seen at Varpelev, Denmark (180,181,182,183) which contained a bowl, beaker, cup and glass object. A burial at Hopperstad, Norway (334,335) contained a filigree jar and a small flask. Claw beakers appear in pairs on two occasions, at Gamla Uppsala, Sweden (619,620) and Vendel, Sweden (747,748) but in each instance other vessels are present in the same grave. In the Vendel burial both claw beakers are incomplete. Other incomplete vessels appear in a burial at Salthammer, Norway (419) containing a complete beaker (418) and fragments of a "cased" vessel and at Birka, Sweden (618,619,620) which contained fragments of a funnel beaker, fragments of an indeterminable vessel and a fragment of window glass.

Some mention has already been made regarding the significance of the position of the glass vessel within the burial. These only seem to be recorded in isolated examples, notably from the Roman and Migration periods. It should however be argued that other examples occur which conflict with the ideas of glass being an important artefact. Fragments from a vessel from Time, Norway (437) were placed in the burial next to a quantity of iron tools and implements above the head of the body. This position in relation to the skeleton is usually reserved for the personal or valuable items. Here the valuable metal artefacts (bronze and gold) lie at the feet. A possible interpretation may be that the iron tools and the glass have some occupational significance, otherwise a deliberate association is difficult to explain. The burial was that of a male and can be compared to an inhumation burial at Birka grave 750, Sweden (520) where the glass is positioned next to an axe and iron tools. This is double inhumation containing a male and a female but the grave goods are positioned next to the male. The female clearly plays a subservient role and this situation can be compared to another double burial from Birka grave 644 (515). where the glass vessel is also positioned next to the male. In another male inhumation grave in Birka grave 850 (523) the vessel is carefully positioned by the handle of the sword at the side of the body. A shield lay at the head and a spear by the feet. Apart from the glass vessel the grave goods consisted solely of arms.

Any particular significance attached to the glass vessel is unlikely to be fully realised from the limited evidence available. These examples above offer a few illustrations of the contexts in which glass was used.

Without doubt they indicate that glass seems to have been treated with greater regard than most other artefacts, although the exact nature of this status is at present unknown. In Birka grave 649 (516) the glass was positioned in isolation on a slight rise, as though it had been singled out for some special reason. This special treatment at times of death in turn suggests a similarly high regard in daily life.

CHAPTER TWO - REFERENCES AND NOTES

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CHAPTER 3 - GLASS VESSELS IN OCCUPATION LAYERS

The remaining group of glasses are those from contexts generally described as "occupation layers". With one exception all are fragmentary, the exception being the restored beaker from Dankirke, Denmark (034). For study purposes the remainder can be divided into two groups, the first group consisting of fragments which appear from destruction or midden levels of isolated structures, and the second consisting of those fragments which occur in numbers, usually in places of larger settlement. The former contains the sixteen fragments listed below:

<u>Cat. No.</u>	<u>Location</u>	<u>Date</u>
010	Bornholm	Migration
011	Bornholm	Migration
012	Bornholm	Migration
024	Denmark	Migration
037	Denmark	Migration
040	Denmark	Roman
192	Gotland	Migration
194	Gotland	Roman
458	Norway	Vendel
722	Sweden	Roman
754	Sweden	Vendel
771	Öland	Migration
772	Öland	Migration
791	Öland	Roman
795	Öland	Migration
802	Öland	Migration.

Their locations and approximate dates may be of little value perhaps only reflecting the state of existing excavations. Nevertheless the noticeably high proportion of Baltic finds especially from Bornholm and Öland may hold some significance. The general dating is worthy of note in that the majority of fragments are from contexts dated to the Migration period. It was hoped to make a study of types of structure

and associated finds, but owing to the frequently sparse nature of the recorded information this was not possible.

According to the evidence available most of the fragments appear from contexts associated with habitable structures as opposed to workshops or open areas. The type of structure and the associated finds indicate that the buildings seem to have been ordinary homesteads supplying the domestic needs of agrarian peoples. The fact that in at least two instances the structures showed phases of rebuilding indicates that they were positioned with a specific convenience for the land and farming. Sociologically, little can be said about the class of the inhabitants, but the presence of silver coins on two of the sites may suggest that their occupations were not unrewarding and that their status in life was not mean. Perhaps they can be compared to the prosperous Danish farmers in the Roman Iron Age whose grave goods, including imported bronze and glass we see at death in the burial. It is more than likely that these structures represent the homes in which such people lived and the environment in which the glass was used. The finds from several of these structures such as the coins from Ibsker, Bornholm (010), the bronze vessel and fibula from Farre, Denmark (040) and the bronze artefacts and coins from Bro, Gotland (192) show that the wealth known from burials existed as a part of daily life. Despite this testimony of comparative wealth, mention should be made of the more mundane artefacts discovered, such as fragments of pottery, bone ornaments and simple iron tools. These domestic items from the same context place the higher quality artefacts in a more realistic perspective.

Most of these fragments are of indeterminable form and decoration, although several of them seem to have associations with beakers of the "Snartemo" type (010,037) or even the claw beaker (458,771). Their presence in small isolated fragments suggests that they are debris caused by breakage and thus constitute refuse. One might therefore expect them to appear outside rather than inside the structure in midden layers and indeed this seems to be the case. Such examples appear from Ibsker, Bornholm (010,011,012) and from Burs, Gotland (194). A fragment from Ås, Öland (802) appeared in a refuse pit outside the structure. Only one fragment is recorded as appearing inside, this being from Bro, Gotland (192). The unusual context of the glass from Västra Karaby, Sweden (754) may require some explanation. Here the structure is a 'grubehaus' and the glass fragment was found in an interior layer in association with a bone comb and a sword pommel (Vendel Style B). This excavation is at present unpublished, but I have been kindly informed by the excavator that the structure is not thought to have been used as a dwelling place. Further excavations may explain the relevance of the context.

The second group of vessels consist of the fragments from the more complex settlement sites, and contains a minimum number of 161 individual glasses. They are listed as follows.

<u>Cat. No.</u>	<u>Location</u>	<u>Date</u>
030-4	Dankirke, Denmark	Migration
202-4	Fröjel, Gotland (Vallhagar)	Migration
339-89	Kaupang, Norway	Vendel/Viking
533-8	Birka, Sweden (black earth)	Viking
547-94	Ekerö, Sweden (Helgö)	Roman & Viking
626-35	Gärdlöse, Sweden	Migration
737-40	Valleberga, Sweden	Vendel/Viking
773-86	Grasgård, Öland (Eketorp)	Migration & Viking

Three fragments from Fröjel, Gotland (Vallhagar) appear from contexts closely resembling those already discussed. The site itself consists of a complex of structures and boundaries belonging mostly to a farming community. Building 2 which was a dwelling house yielded domestic debris including pottery sherds, loomweights, small iron implements and animal bones. A fragment of glass (202) probably belonging to a beaker of the "Snartemo" type was found close to the hearth, a position held in common with many of the other artefacts. The house itself is thought to have been destroyed by fire sealing many of the finds in the approximate region of their last use. The density of items around the hearth caused the excavator to postulate that the glass beaker, "presumably the proudest object in the house" had been kept in this focal position by the fire ⁽¹⁾. The other fragment (203) from Building 2 was found outside the walls and to the north and was associated with the building through proximity rather than through stratification. The final fragment from Vallhagar (204) was discovered inside Building 16, a smaller structure than Building 2 and described by the excavator as a "Gotlandic peasant house". In this house the majority of the finds appeared from between the walls and the sleeper beams, presumably under the bench or bedding planks. The glass fragment lay in the same area. The structure had a central hearth and the associated finds included items for spinning, weaving and cooking. From the archaeological evidence and from the size of the structure in relation to others on the site Building 16 seems to have been one of the least wealthy habitations. The presence of glass is therefore of particular interest.

Similar types of glass fragment appeared from Gärdlösa, Sweden (626-35) but these are unpublished and the nature of the archaeological context is not available. The ten fragments, all dated to the Migration period, are from vessels of indeterminable form and only a few of them exhibit the slightest traces of decoration.

Perhaps the most curious of all glass finds from settlement sites are those from Dankirke, Denmark (030-4). The dating of the structure complex to the Migration period, particularly to the later part, provides the few known glasses from this period in Denmark. Excavation is still in progress, and has so far yielded the remains of possibly 20 vessels, five of which are included in the catalogue. These comprise of a restored beaker of dark blue glass with applied horizontal and vertical trails (034). The other vessels are all in fragmentary form and consist of three glass drinking horns (030-32) and a fragment possibly from a claw beaker (033). The structures themselves date from the Roman Iron Age and were eventually destroyed by fire in the sixth century. The fragments belong to the later occupation of the site. Although later ploughing had partially destroyed the stratigraphy, the dark blue beaker (034) was discovered sealed under the destruction layer and contained the residue of a liquid. Other finds from the complex included numerous decorated pottery vessels, iron tools and implements and iron spearheads together with several items of personal ornament such as bronze brooches and pins. Also found were a large quantity of coins. Unfortunately it is not yet possible to comment on the type of structures or their significance. One can only conclude by saying that the finds so far indicate considerable wealth and suggest that there was

direct trade contact with the rest of Europe.

With regard to the type of structure in which glass fragments have been found the "grubenhauser" from Valleberga are the most problematic. This settlement, consisting of thirty sunken huts of differing shapes and sizes is mostly dated to between the seventh and tenth centuries. Three of these structures contained glass fragments, House 7:67 (737), House 2:70 (738) and House 4:70 (739,740). There is no structure throughout the site which could be described as typical. Even the number of post-holes associated with each is inconsistent. The finds, however, tend to fall into two groups. One group of huts seemed to yield iron objects in some numbers together with pottery sherds and animal bone, while the other group yielded spinning whorls, beads, pottery sherds and often a whetstone. Each of the glass fragments appeared in the second of these groups. There is little evidence either way to suggest the function of the structures, although in terms of their size it is unlikely that they were used as dwellings. The possibility of working areas is more likely and perhaps the glass fragments were used for purposes of re-manufacture into other glass items such as beads. Glass rods, wasters and beads were also found on the site. It is interesting, however, that none of the three huts in which the fragments were found contained a hearth. Other houses containing major central hearths were clearly used for industrial purposes, but there is no other evidence to suggest that glass was part of this process. Valleberga is situated close to the trade route from the Rhineland to the Malaren region and therefore the circumstances for trade in fragments would be available. No other solution can explain glass fragments in this type of building in

this particular period of time when glass is relatively rare in the south of Sweden.

The excavation of the Viking centre at Birka, Sweden produced several fragments of glass from the 'black earth' area, and this number has since been supplemented by more recent work. The fragments themselves, in terms of their form and decoration, are in keeping with the glasses from the Birka burials. Of the six fragments found from the early excavations four belonged to funnel beakers (434-437), one to a vessel with filigree decoration (538) and one was unidentifiable (433). Filigree glass is discussed in some detail in Appendix II. The recent excavations (not included in the catalogue) have yielded further fragments of funnel beakers, and fragments of other vessels all of which could be identified from complete vessels in the Birka cemetery⁽²⁾. One can assume from this evidence that glass from the culture layers, and therefore the glasses used in daily life, were no different from those placed in the graves. The Birka fragments and glasses show that the transmission of vessels from domestic use to the burial was an accepted practice, and judging from the number of burials containing glass at Birka it may be possible to assume that glass itself was a relatively common artefact. Furthermore it infers that glass was often a necessary part of the requirements for the Afterlife.

Contexts in which occupation remains and burials can be compared are not common. However, the relative density of glasses from the Birka sites is likely to have been created by Birka's strategic commercial position and wide trading contacts. Another site with a similarly

important position is that of Eketorp, Öland (Grasgård parish). Here the structures have been the subject of intensive investigation and in this respect provide a more suitable domestic context than at Birka. There are, however, no burials. Geographically, Öland is in a significant position with regard to the Baltic trade routes. Eketorp, which lies on the southern tip of the island is important not only for access to these trade passages, but also for the spread of artefact contact into the east of Sweden. The first settlement at Eketorp appeared before the Migration period and is not fully understood. However, during the Germanic period a circular curtain wall was constructed inside which a village settlement grew. After a period of abandonment the site was re-used and yielded evidence of structures and finds dated to the Viking period. These two phases of occupation were quite different. The Germanic phase was essentially a protective enclosure for the local population in times of danger and contained dwelling houses, storage buildings and areas for cattle. The Viking settlement was a permanent settlement and underwent a period of refortification in common with many other towns on the Baltic coast and in Denmark. In this period the population consisted not only of the farmers and fishermen known from the earlier phase but also of traders and merchants who seem to have conducted their activities on a considerable scale. More important perhaps is the fact that by this time Eketorp had formed itself into a proto-urban community with the ability to carry out those activities. This suggests the presence of a stable and prosperous community.

The glass fragments from the Germanic phase are twelve in number. Many of these fragments belong to the "Snartemo" type of beaker (774,775)

and some to vessels with faceted decoration (777,778). The remainder are unidentifiable. The number of fragments is remarkably high considering the refuge nature of the site at the time. One can only assume that the proximity of the trade route was responsible for this. Gårdlösa, well-placed for the same trade route showed a similar high number of fragments. The distribution of Migration period glass shows that the remainder of south east Sweden, particularly Småland, is almost without example. The fact that Eketorp was not a permanent settlement at this time and therefore perhaps could not be expected to yield items appropriate to a static community serves to emphasise the nature of the trade contact.

The fragments from the Viking phase should theoretically be greater in number, due to the fact that the community was settled and offered a stable domestic environment in which glass could have been used. This does not appear to be the case. Only two fragments appear, one from a filigree vessel (797) and one possibly from a claw beaker (782). This number is all the more significant bearing in mind that other imported goods become more numerous at this time. In comparison the use of glass vessels on the site appears to have been in a decline. This decline can only have been brought about by a closure of a place of manufacture rather than by the closure of a trade route. It is interesting to note that there is only one example of glass from a burial in Gotland after the Vendel period. There too there is no lapse in the quantity of other imported goods. This strengthens the theory that the place from which the Baltic islands received their glass either no longer manufactured or no longer supplied these areas. Bornholm too can be included. Despite

considerable Viking activity which existed there, no glass finds are known from excavations dated later than the Migration period.

The remaining two locations of finds are at Kaupang, Norway and Helgö, Sweden. Excavations at both sites have shown evidence of considerable trading activity, and particularly in the case of Helgö, considerable local manufacturing. Kaupang, which lies hidden in a natural coastal inlet in Vestfold has shown evidence of both settlement and harbour areas, and according to the results of the excavations seems to have been a trading base in the Vendel and Viking periods. Helgö has in many respects been more fully examined and consequently the evidence is stronger. The situation of the site on a strategic island in lake Mälär linked the trade connections between the West and the East and this is evident in the finds. These include artefacts with Celtic type decorations, a bronze statuette of Buddha and numerous eastern coins together with items of local manufacture. The site itself contains a single culture layer spanning approximately the time between the Roman and Viking periods. Both sites have much in common with their activities depending almost entirely upon the sea and the Scandinavian tradition of sea-faring. Although excavation at both sites is still in progress the evidence available provides a very suitable background against which to examine the significance of the numerous glass fragments which appear in both places in greater density than anywhere else in Scandinavia.

From Kaupang fifty-one fragments are recorded in the catalogue. All are from occupation layers and all are associated with the main period of settlement. Several of these fragments belong to specific types of vessel. Sixteen probably belong to funnel beakers and one (360)

seems to belong to a claw-beaker. Four fragments exhibit filigree rod decoration, two with yellow spirals and two with white spirals. Apart from three fragments of window glass the remainder are from vessels of indeterminable form and decoration. A point worth mentioning is that the fragments are all small in size and do not allow any vessel reconstruction. In many, but not all cases, each individual vessel is represented by only one small fragment, One can compare these to other settlement fragments such as those from Vallhagar or Eketorp which generally speaking are greater in number per vessel as well as being larger in size. In domestic circumstances one can visualise a broken vessel being swept aside or cast out presumably lying in large pieces or in groups of fragments. At Kaupang this is not the case and it may be possible to assume that their presence on the site has no domestic basis. Another factor should be introduced here, namely the colouring of the fragments, which in the most part are extremely highly-coloured with many exhibiting bichrome decoration. The site also yielded glass wasters, rods and beads. It is possible from this weight of evidence that glass was worked on the site. The probability of importation of glass fragments is high and would explain the apparent anomaly between the types of fragment at Kaupang and those from most other occupied sites. Evidence for workshop activity is less strong than at Helgö but the present absence of archaeological evidence in no way prevents this possibility. It would therefore be a valid suggestion to maintain that the majority of fragments from Kaupang reflect a trade in glass fragments for the purpose of remanufacture into other items. Wasters and associated glass material may indicate stages in this process.

The same process may be true for Helgö, from where the remains of sixty nine vessels are included in the catalogue. Again there is a high proportion of funnel beakers, claw-beakers and filigree vessels as well as the earlier forms of glass type and decoration such as the faceted and medallion beaker. The same factors arise as at Kaupang. The majority of the fragments are small in size and appear to belong to different vessels. They are nearly all highly-coloured and many have bichrome or even polychrome decoration. For example the filigree fragments contain a variety of coloured spirals in opaque white, blue, yellow and red. Many of the fragments of claw-beakers exhibit coloured trails or coloured decorative nipped bands. Certainly the fragments from both sites show a great deal of similarity although in terms of structures and working areas Helgö is currently richer. Helgö has yielded evidence for metal-working in the form of crucibles, slag and moulds. The excavations have shown quite conclusively that Helgo was essentially a workshop site and consequently the glass fragments which seem confined to a specific area must have some significance. One cannot explain the sheer quantity as being due to domestic breakage on a site which is predominantly industrial. Again there is evidence for glass working in the forms of wasters and rods. The same conclusion can be drawn as at Kaupang, namely that a trade existed in glass fragments for the purpose of remanufacture. This is a plausible theory for both sites, yet in both instances evidence for such a process is not fully apparent. There are no crucibles containing glass residues or paste, nor are there any hearths containing glass slag and waste. Our knowledge of glass working at this time is insufficient to ascertain the nature of the evidence available and to gauge its validity.

Outside Scandinavia there are three other sites which have yielded similar types of evidence to both Kaupang and Helgö. The Brough of Birsay, Orkney has been the subject of excavation since before the war and several fragments of glass were discovered in a context associated with a period of Norse occupation⁽³⁾. The site itself has shown evidence for metal-working in the form of moulds, crucibles and slag. Again the fragments are small and highly-coloured and were discovered in one particular area. They also include glass wasters and beads. Apart from this there was no other evidence to suggest that glass was worked. Recent excavations however, have yielded pieces of glass or enamel slag. Once again finds such as these provide suitable grounds for the theory of glass working.

Excavations at the Mote of Mark, Scotland conducted in the early part of the century showed a similar type of site⁽⁴⁾. Glass fragments, evidence for metal-working and a geographical position of some importance in the Irish Sea Culture all point towards the same conclusion. Here the glass can be dated to the Merovingian period and the fragments are all small in size and all coloured. Finally Dinas Powys in Wales dated to a slightly earlier period should be mentioned. Metal-working is apparent and the few glass fragments found are considered by Dr. Harden to have been brought to the site for re-manufacture⁽⁵⁾. The presence of glass beads and rods strengthens the theory.

The evidence shown by these sites seems to imply that trade in glass fragments as well as complete vessels took place on a considerable scale. Evidence for use of the material in a secondary process as outlined in Chapter 1 is still sparse, but nevertheless the practice of re-working fragments must remain a strong possibility.

CHAPTER THREE - REFERENCES AND NOTES

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- (5) Alcock L. Dinas Powys, on Iron Age, Dark Age and early Mediaeval Settlement in Glamorgan. Cardiff 1963, p.52f.

CHAPTER FOUR - METHODOLOGY AND THE PROBLEM OF FRAGMENTS

The differing methods applied to archaeological material are illustrated in no better way than in reviewing existing publications which discuss Scandinavian glass vessels. The initial division of each work into pre-set chronological phases is one of the more significant factors open to criticism. For the purpose of this thesis all chronological definitions are made according to Swedish chronology. The systems adopted by both Denmark and Norway differ mainly by reason of terminology and not to a great or significant extent by discrepancies in dating. I hope to illustrate below why these fixed standard Scandinavian chronologies may not necessarily be relevant to the field under study. In the catalogue it was important to establish some form of dating for the archaeological context of each item. Closely-dated items could be recorded to within one hundred or even fifty years on an absolute scale, but in many instances the dating could only be defined within the broad terms of chronological periods. These periods are outlined below and the definitions used are those followed in all chronological discussions in this work.

Early Roman Iron Age	-	AD 50 - 200
Later Roman Iron Age	-	AD 200 - 400
Migration Period	-	AD 400 - 550/600
Vendel Period	-	AD 550/600 - 800
Viking Period	-	AD 800 - 1050

This is essentially the system devised by Montelius with the accepted

flexibility at the end of the Migration Period and the beginning of the Vendel Period (1).

Method of existing works

The basic pattern of most works specialising in glass of these periods is orientated towards a conventional recording of information showing types and distribution. From this arises the interpretation. The Roman Iron Age is represented by two major works by Ekholm which deal with the imports from the Western and Eastern Empire into Scandinavia together with resulting distribution patterns (2). The study of glass vessels from the Eastern Empire was supplemented by a more recent article (3). Similar methods were employed by Eggers whose research was spread over a broader geographical area and covered a wider range of artefacts (4). This offered a more realistic relationship between glass and other imported goods without taking items out of their immediate context. His arguments, however, have been the subject of controversy and this has been discussed elsewhere (5). Both Ekholm and Eggers were concerned in the main with typological development and distribution until the year AD 400, although Ekholm pursued the so-called "degenerate" types which lingered into the early sixth century. The works by Ekholm are discussed here in some detail for the reason that the inconsistencies in his method are characteristic of many studies devoted to artefacts. Eggers' work is treated more succinctly.

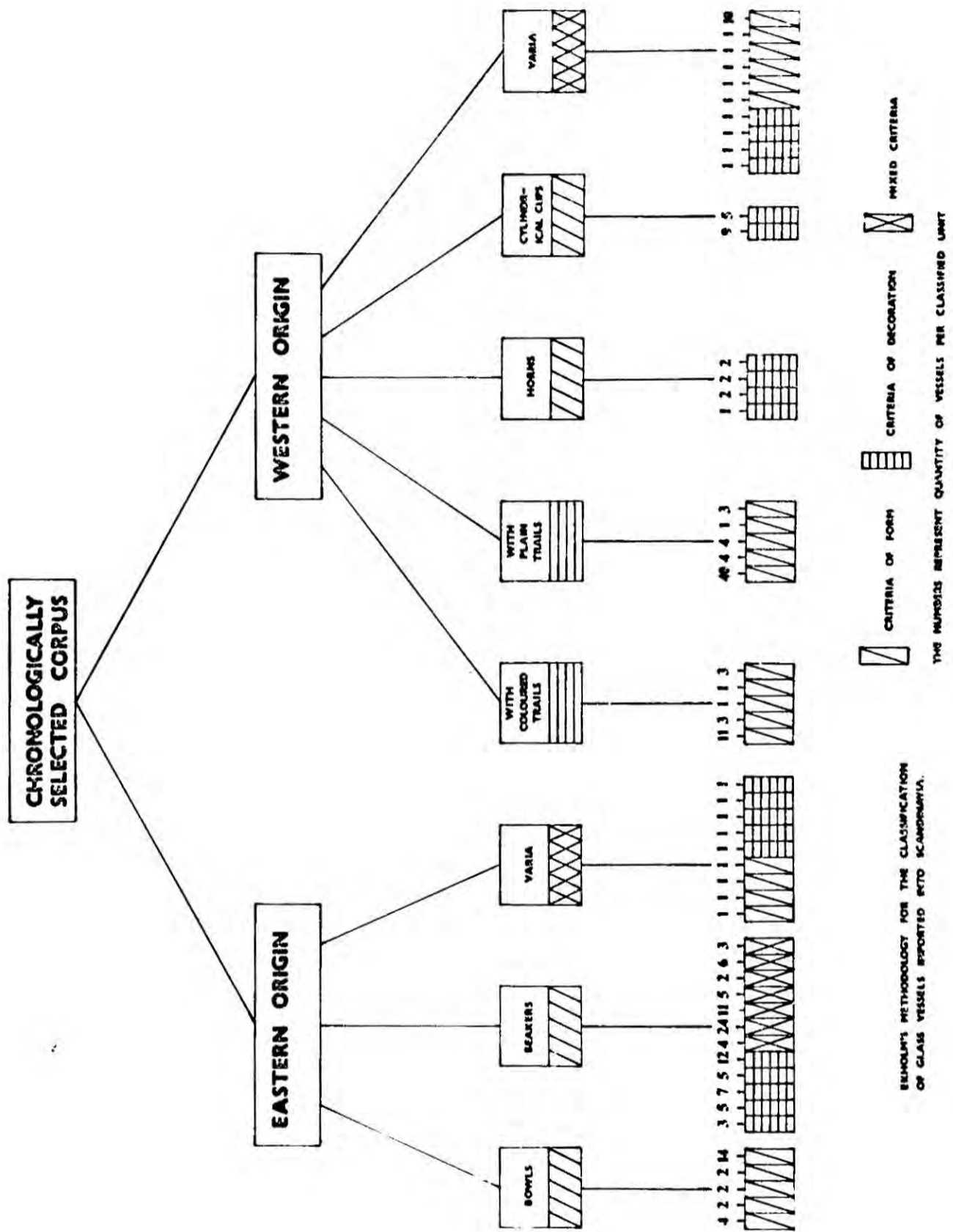
The most noticeable feature of all Ekholm's works is in the variation of basic approach and definitions of classification. In 1956

he divided the corpus of material into two basic functional types of vessel (6). These were headed "bowls" and "beakers" and included a total of twenty-six sub-divisions. This is tabulated in fig 3 together with the method used for the classification of the material of western import. The bowls consist of five types listed in the order below.

- A. Pillar-moulded bowls
- B. Bowls with trails
- C. Lotus bowls
- D. Semi-spherical bowls
- E. Bowls with ground or incised decoration

The deciding criterion for each group is the decoration, with the possible exception of Group D which appears to be based on form. In the first four groups there was a 1956 total of only ten vessels. Group A was represented by two identical pairs, Group B by one identical pair, Group C by fragments of two vessels and Group D by two complete vessels. Group E consisted of twelve vessels, ten of which could be assigned to either bowl or beaker category. Ekholm makes no comment regarding his definition of either bowl or beaker in relation to any proportional characteristics. Decoratively Group E is more in keeping with the beaker category. As the difference between beakers and bowls is presumably one of function Group E is clearly not a satisfactory category. The disregard for proportional differences throws both large and small vessel into similar groups. Size and relative proportion are indicative of function and therefore cannot be grouped together here on decorative grounds.

FIG 3.



The other category, beakers, was divided into twelve groups denoted under the following headings:

- F. Faceted beaker with foot.
- G. Faceted beaker without foot.
- H. Faceted beaker without foot.
- I. Vorning type (186).
- J. "Cased" beakers.
- K. Beakers with ground ovals and foot.
- L. Cylindrical beakers with ground oval decoration.
- M. Conical beakers with long ovals.
- N. Conical beakers without ovals.
- O. Bremsnes type (306).
- P. Foldvik type (317).
- Q. Øvsthus type (457).

These twelve groups can be said to be defined according to three criteria, namely the shape of the ground decoration, the presence or absence of a foot and the profiles of the respective vessels. The approach is inconsistent with regard to the formation of the groupings. Groups I, J, O, P and Q are formed using decorative criteria, while the remainder, F, G, H, K, L, M and N, use both decorative and form criteria simultaneously. He defines a group in the manner "faceted beaker with foot" (mit Facettenschliff und Fussplatte) which assumes decorative elements (the faceting) as well as form elements (the foot) at the same descriptive stage.

The variation in profile ranges from the beaker with the rounded base to those of conical form. In a further article in 1956 Ekholm attempted to produce a typological sequence for this phenomenon (7). The development he traced required a period of some one hundred years in which the beakers with the rounded base evolved to the conical variety. His reasons for the development are logical enough, yet they are founded solely on aspects of form. He failed to point out that the development which he so decisively illustrates may have required a total alteration of function for the vessels concerned. The round-bottomed beakers were free standing while the so-called developed conical variety were unstable. It would seem an obvious step to comment on the implications which arise from this ordered typological theory. Certainly the glasses drawn together in the beaker groups are given no functional sub-divisions.

The third category included in the main 1956 work contained those vessels which he could not safely assign to either the bowl or beaker categories. He produced nine different types each represented by a single vessel, and this category provided a convenient niche in which to set those vessels (or fragments) which were either unique or sufficiently unusual. The criteria he uses appear to consist of a mixture of those used in the two major categories above. These vessels are listed below together with their assumed functional type and the criteria Ekholm apparently used for their definition.

<u>Vessel</u>	<u>Function Type</u>	<u>Criterion used</u>
Solberg (426)	Jar	Form
Herlufmagle (046)	Jar	Form
Killerup (070)	Beaker	Decoration
Hallem (326)	Beaker	Decoration
Søtvet (345)	Beaker	Decoration
Addit (022)	Jar	Form
Nordrup (140)	Jar	Form
Salthammer (418)	Beaker	Decoration
Varpelev (180)	Bowl	Decoration

The criteria used in establishing the individual groups seem to be based on a combination of form and decorative elements. The format may be indicative of a functional difference, and perhaps one ought to see the jar types from Herlufmagle, Addit and Nordrup in a separate group from the very beginning. The same could be said for the Solberg vessel, although it should be remembered that this vessel is fragmentary and is reconstructed in association with the famous Portland Vase in the British Museum.

At this stage one might well suspect any system which has nine categories each represented by a single item. One wonders whether the main system of approach is at fault or whether the vessels under discussion were too restricted in number. This is also reflected in the bowl category where there are a minimum of five complete vessels from four different groups. Perhaps this emphasises the need to discuss the problems within a broader geographical context.

The second article written in 1965 was based mostly on the same material yet was organised in a totally different way (8). The 1956 work divided the corpus of material into primary categories defined by function type while this later work used a primary approach based on elements of technique. The shift of emphasis is not only remarkable in itself but also in that it produced a mixture of both the typological (here technical attributes are used as typological elements) and functional approaches. Certain vessels were therefore able to be classified in one or more different groups. In the first instance the material was divided into four groups based on technical characteristics. These are as follows:

- A) Pressed (moulded) bowls.
- B) Vessels with ground decoration.
- C) "Cased" vessels.
- D) Others.

Group A was sub-divided into three parts each defined using decorative elements yet contained only eight vessels six of which were in pairs. Group B is somewhat larger and is sub-divided into four groups. We should expect decorative elements to be applied at this stage for the reason that they were applied at the equivalent descriptive stage in group A. The confusion appears again. Three groups are defined decoratively while the fourth contains a form element. A further sub-division of these groups is of a similar inconsistent nature and mixes form (presence or absence of foot) with decoration (type of ground decoration). The remaining groups C and D are not sub-divided further.

Ekholm's 1958 article discussed glass vessels of W. European origin from the Scandinavian Roman Iron Age. This is also shown in fig 3. The division of the corpus into four basic categories was again inconsistent. The first two were defined by decorative criteria and the second two by means of form. The method of division is as follows:

- A) Vessels with trails of different colour to vessel.
- B) Vessels with trails of same colour as vessel.
- C) Drinking Horns.
- D) Cylindrical Beakers.

The classification of the sub-division was of a similar nature producing the analysis below:

<u>Groups</u>	A	B	C	D
<u>Primary Approach</u>	Decoration	Decoration	Form	Form
<u>Secondary Approach</u>	Form	Form	Decoration	Decoration

The third major work on glass from the Roman Iron Age was published by Eggers in 1951 ⁽⁹⁾. Here there was no distinction between eastern and western imports and the range of artefacts included all associated items from graves. Eggers listed 72 drawings of different vessels which appeared in Scandinavia and Free Germany. The result of his efforts assigned all types to one of the seventy-two standard examples. Slight variation in places was permitted, but this accounts for a very small number of vessels which did not fit exactly into one of those types. His main conclusions lay in the production of distribution maps which in turn gave rise to a hypothetical map of contemporary trade routes. His

aims were not to investigate the types and development of glass vessels in themselves but rather to clarify an overall archaeological environment. As far as the glass vessels are concerned his basic approach was the definition of form with a secondary approach defined by decorative criteria. Essentially the method is chronological (i.e. he discusses vessels from the Roman Iron Age), then typological. In the typological process form clearly precedes decoration as a comparative element. His method is therefore consistent, but the large and comprehensive nature of the work as a whole prevents the discussion on glass from being more than superficial.

The works of both Ekholm and Eggers illustrate the two major difficulties which arise in any discussion relating to glass studies. Any detailed analysis requires rigid definitions and a strong concept of order. The greater the detail required, the more problematic the methodology. In terms of content, Ekholm's works cannot be faulted, only the methodology is suspect. Nevertheless, the methodology affects the interpretation so fundamentally that the effort seems sadly wasted. Eggers, whom I passed over more quickly reflects the opposite fault. A superficial survey, especially one carried out in relation to associated items, invariably seems inadequate for the study of an individual item. This is a natural and practical limitation. However, such a survey is invariably consistent in methodological approach. The wider orientation makes impossible the detailed study of the individual item. In losing the detail, we are deprived of the study of function, form and ornament which are the intrinsic elements of the objects and reflect the needs and stylistic values of the people who used them.

The problem of fragments

The material which both Ekholm and Eggers used contained many incomplete items of glass. Both dealt with fragmentary remains in their surveys but did so in different ways, neither of which was satisfactory for a detailed study of glass. In the 1965 work Ekholm included certain fragments in his existing typological series on presumption of obvious parallels which may or may not be correct. On the other hand, Eggers mentions fragments which he considers to be unrecognisable in their existing form, but confines them solely to a contextual reference in the inventory groupings of grave lists. In his distribution maps they are ignored because these maps are confined to specific types. At the end of his work is a distribution of his "scherben" but this is not in association with anything else. This problem can be illustrated by drawing attention to the ratios of complete to unrecognisable fragments taken from Eggers' lists for Denmark, Norway and Sweden.

	<u>Complete</u>	<u>Unrecognisable</u>
Denmark	2	1
Norway	8	3
Sweden	2	1

The evidence for the distribution maps is based on little more than 60% of the material available. Of the glass discussed by Eggers from the Roman Iron Age approximately 40% is fragmentary. The catalogue here shows that in the first millennium AD approximately 65% of the material is fragmentary. Clearly some method must be devised by which these fragments can be utilised.

All the publications so far discussed took their evidence from complete or nearly complete vessels. This might be acceptable in an artefact series which is rich with distinct types but pre-mediaeval Scandinavia has so far not produced glasses to this extent. The above approaches to the problems which fail to comply with standard norms of procedure adhered to in other disciplines cannot be accepted here.

These problems of methodology with regard to glass are those which become more apparent in Scandinavia in the periods after the Roman Iron Age where the quantity of material is smaller and the proportion of fragments significantly higher. Our knowledge of the vessels from the Migration, Vendel and Viking periods is scanty and owing to the sparse nature of the finds vessels are usually dealt with individually or within the context of their immediate discovery. In nearly all instances the vessel (or fragment) is discussed with particular reference to existing parallels. Certain glasses from the Vendel period have been published in this manner and related to a corpus of other known glasses from the same period ⁽¹⁰⁾. Glass from the Viking period, based on the rich material from the Birka graves also included much fragmentary material fortunately supplemented by several complete items ⁽¹¹⁾. Professor Arbman's treatment of these vessels with regard to their Carolingian parallels is one which illustrates all too well the paucity of Scandinavian Viking period glass outside Birka ⁽¹²⁾. Glass of a similar and earlier period in Norway has been discussed by Hougen, but here again, the corpus is small and the majority of the samples fragmentary ⁽¹³⁾.

All these works are based in the first instance on chronology for the sole reason that the Scandinavian Iron Age is traditionally discussed in terms of the Roman, Migration, Vendel and Viking periods. Scandinavian glass of these periods is presumed to be imported and therefore the types and styles may be subject to changes and developments which have no correlation to any Scandinavian influence. Consequently any chronology formed will only be relative to that of native Scandinavian artefacts. Furthermore, the factors of production which rely upon the existence of skilled craftsmen will also be non-Scandinavian. The necessary political and social situations for quantitative output in the country of origin and the ease by which trade could be carried out are all factors which would affect the supply and quality of the vessels. None of these factors may have any Scandinavian relevance. We may state with reasonable certainty that Scandinavia had no influence whatsoever on the production of glass on the continent or on the styles which were developed there. It has nevertheless been considered by Ekholm that the exporters of these vessels had certain commercial principles in mind and manufactured vessels with regard to quantity before quality and strength before elegance ⁽¹⁴⁾. They may have been specifically intended for distant export to barbaric peoples. There is no work which covers all periods and shows the typological development of glass vessels. Instead it has been conventional to restrict the development to within a small chronological period regardless of the sparse material, and in many cases regardless of continental parallels and influence.

No single work has attempted to classify the glass vessels of the

Migration period. These vessels are too closely linked with those of the Roman period to permit study in isolation. The main works which cover these glasses are by Ekholm and have already been discussed. It only remains to say that while the development from the Roman to the Migration period has been attempted by Ekholm, no scholar has yet satisfactorily commented upon the development from the Migration period to the Vendel period. Consequently the resultant picture formed by these glass studies is disjointed. As long as glass is persistently studied in divisions of barely two hundred years this situation will remain.

The Migration period on Gotland has been comprehensively documented by Nerman in the tradition of Scandinavian close-dated chronology ⁽¹⁵⁾. Nerman's subdivision of the period and treatment of the finds is one which shows chronological development of style in the Gotlandic material. This can be adapted with no small success to comparative material from mainland Sweden. Gotland, being one of the richest areas, can in the main be said to show development parallel to the rest of Sweden although certain characteristics are idiosyncratic. Nerman divided the Migration period into two parts (VI:I and VI:2) following the same system devised by himself and Almgren for the earlier Roman period ⁽¹⁶⁾. The Gotlandic finds were such that association and dating allowed small chronological sub-divisions to be made. With regard to the glass finds in both these works, there was little emphasis on typological development factors and the glass vessels from Gotland were discussed strictly as they appeared in the chronological sub-divisions. There was no overall picture. Although this is not helpful in establishing the complete development of

glass vessels, it is useful in enabling one to see the associated finds and styles of development in other contemporary artefacts.

The third work based on this system of chronology covered the Vendel Period in Gotland ⁽¹⁷⁾. Only the volume containing the plates and inventory was available at the time of writing and this shows that all the artefacts are divided into five consecutive periods of fifty years each. As the Gotlandic method of study is in the first instance one of chronology, it is interesting to determine the ratio of complete to unrecognisable or fragmentary vessels from the two earlier periods.

	<u>Complete</u>	<u>Fragmentary</u>
Gotland - Roman Iron Age	1	5
Gotland - Migration	3	7

Most of the material has now been supplemented but the above figures indicate that if the material is very fragmentary and in many cases cannot be recognised as a specific type then a primary chronological approach derived from associated artefacts is a useful method of grouping. This is amplified in chapter 6 with the entire corpus of material in an effort to establish the most accurate and practical method of classifying the objects.

Scandinavian glass of the Vendel Period has been discussed by Arwidsson to a much greater extent ⁽¹⁸⁾. In this major work of the artefact styles of the period she drew up a list of all the glass remains from that period known in Scandinavia. This contained a total of thirty-six vessels. Of these only fourteen were completely recognisable as specific vessel types. The remainder consisted of melted fragments or small sherds

and were dated to the Vendel Period by associated finds rather than by their own typological characteristics. Attempts to classify these fragments appear futile and a description such as "feuerbeschadigte Fragmente eines Bechers, moglicherweise eines Russelbechers" is not helpful. Again the ratio of fragmentary vessels to complete vessels is high being 11 : 7. Only 35% of the vessels can be recognised by visual typological means, the remaining 65% can be recognised only as the substance glass presumably associated with the existence of drinking vessels. Consequently the application of visible descriptive criteria cannot be made. In an instance such as this it becomes almost impossible to classify or comment upon glass development. Unlike the earlier Roman period there is no scope to form a complex methodology. Instead the complete glass vessels are dated by association and the fragments are often either ignored or assumed to be from types already found complete. The major glass finds from this period have been from the provinces of Uppland (graves at Vendel and Valsgarde) and Sodermanland.

The final period under discussion in the study is the Viking Period. Vessels from this period are perhaps the most rare. The grave-field at Birka and the excavations at Kaupang and Helgö have both yielded unexpectedly large quantities of complete and fragmentary vessels. The Birka graves produced eighteen complete vessels, mostly of the funnel beaker type, against thirty-seven fragmentary vessels, the majority of which Arbman also considered to be funnel beakers ⁽¹⁹⁾. The sites of the trading centres at Kaupang (Norway) and Helgö (Sweden) were both rich in imported material. The most surprising fact concerning both is that

although they produced relatively high numbers of fragments compared to any other Scandinavian site, neither produced a complete vessel. Again the methods of approach to the study of glass have to be reconsidered to include this important and statistically significant material. Only one study has been attempted of the Norwegian glass from this period and this was similarly hindered by the fragmentary nature of the material (20). This showed evidence for the remains of no more than six vessels from the Viking period of which only one was whole. The others were therefore dated by associated finds. Typological classification using form and decorative elements was ruled out.

This brief glimpse of the major works concerning Scandinavian pre-mediaeval glass shows many defects in the approach and consistency of method used. These defects can be summarised into two broad parts, the first concerning the conformity of method and the second concerning the problems of the fragments. As we have seen the first defect can be avoided if the material is examined by a consistent method of approach. The second problem is more complex. As an extremely large proportion of the glass vessels in our period is fragmentary then the only method which can be applied to the entire corpus is one which can use these fragments at the primary stage. If this is not carried out then the fragments will be disregarded completely.

The fundamental nature of the problem lies in the way in which the fragment can be used, and the major faults with existing systems of approach can be denoted under two main headings.

- 1) Fragments are often disregarded when they represent a statistically large proportion of the entire corpus of glass remains.

- 2) Fragments are often used to represent complete types when there seems to be an obvious association to a complete type, or at least an association which the specialist considers to be obvious.

The works discussed above have all been based on methods of distinction and classification which are practical. The necessity for practicality has in nearly every instance caused one of these faults to be brought about. This in itself is a basic difficulty of the methodological task.

We must ask if it is possible to reconstruct a complete form from a few fragments. It may be possible to discern the type of vessel in general terms, such as the reduction to a basic form, i.e. bowl, cup or jar, but it is only possible to work on positive evidence. If there are no rim fragments then we cannot comment on the rim form, and unless there are base fragments we cannot ascertain the presence or absence of a foot. Unless we are extremely fortunate we have little on which to gauge height, diameter or specific form. Only in certain instances where a fragment has a special visible characteristic can it be of any real immediate value, but it can still only be discussed in terms of that characteristic element and not in terms of any hypothetical attributes. A fragment of dark blue glass decorated with a specific pattern of gold foil was discovered at Helgö and has been documented at length. In the documentation a correct approach was taken in that it was related in direct terms of that specific decoration and not in terms of the type of vessel (21). This fragment can be indirectly related to other artefacts bearing similar gold foil decoration within the Carolingian Empire and to the distribution and chronology of this type of

decoration, but while the item remains fragmentary it can be related by a minimal number of attributes. It would not be a correct approach to judge complete vessels by one set of criteria and the fragments by another or by none at all. Ideally both fragments and complete items should be subjected to exactly the same forms of comparison.

While it is clearly important not to ignore fragmentary material it is equally important not to assign fragments to existing series without due care. Several instances have arisen in which a fragment has been reconstructed graphically into a complete vessel based on imaginative rather than factual information. Examples of this can be illustrated clearly by references to several dubious (but nevertheless still accepted) reconstructions, particularly in older literature. Although it is often assumed that older literature has in many instances been superceded, or at least that certain interpretations have been modified, this is not always true. Examples of vessels and their typological series have persistently remained unvaried, and the apparent resemblance of fragmentary items to an existing vessel type has seemingly been sufficient for a purposeful association.

Vessel fragments from cremation grave 284 at Kannikegaard, Bornholm (003) which were discovered in the nineteenth century and illustrated in reconstructed form by Vedel continue to be considered in the same light even although the fragments and the reconstruction have little in common⁽²²⁾. Another type of vessel is considered to have been discovered in Östra Tunhem parish, Västergötland (765)⁽²³⁾. Again the reconstructed form is totally hypothetical. Even less credible is the reconstruction based on pieces from Husby parish, Sweden (650) which shows a claw beaker⁽²⁴⁾.

This not only shows a specific type of vessel but also a closely dated sub-type. A similar claw beaker reconstruction exists for the Borre, Norway (305) fragments (25). Other examples include those from Halla parish, Gotland (254) (26) and Vallstena parish, Gotland (293) (27). Later works such as those relating to the Helgo material must also be criticised on this account. One of the polished beaker fragments can be cited here (582) (28). Nevertheless credit must be given to the author who stresses that some of his reconstructions appear to represent unknown vessels. In itself this admission shows that he is aware of the problems of reconstruction and has not allowed himself to be restricted to existing forms. Too often fragments are associated with a complete type of vessel purely because the complete vessel in question seems to bear the most resemblance.

Typology and fragments

As the methodology must be adapted and developed to suit the nature of the material, it is important that it should be workable and applicable to fragments as well as complete vessels. This has been managed with some success with regard to other artefacts, but it has hardly been attempted with glass. In pottery, where the frequency of sherds is extremely high a similar problem has arisen. However, the large proportion of complete pottery vessels has usually been sufficient for a reasonable typological series to be produced. In an effort to utilise the glass fragments we should first look at the manner in which pottery sherds have been treated. Such treatment was attempted by Stjernquist who drew up two initial alternatives (29). These were formulated to show that the archaeologist should

- i) distinguish for study purposes between those sherds which have traces of ornament or details of form, such as a rim, and those that do not, and attempt to study the former, or
- ii) attempt to develop methods for the study of simple sherds.

The second alternative is by far the more satisfactory yet is not an answer in itself. "Simple" sherds are not defined more closely. Presumably they are those sherds which show no traces of ornament or details of form. In this case the majority of glass fragments are "simple" fragments. As a solution to the problem Stjernquist suggests the use of technical analysis to give a comprehensive account of chemical properties which she claims may not be of value unless the properties bear some relation to human activities. At this stage it is opportune to mention Selling's work with mediaeval pottery where one of the chief categories depends on firing temperature (30). Stjernquist herself continues by using different degrees of temper as grouping factors. Technical analyses have been made on many artefacts and for many purposes but the two works mentioned here both managed to relate the results to factors of human activity. Analyses for their own sakes are less valuable.

The advantages of using technical factors in classification, were succinctly outlined by Shepard on three major points (31). These were as follows:

- i) It directs attention to the human factor by making one think in terms of how the pottery was used and thus aids in the definition of a taxonomic unit in terms of cultural factors.

ii) It enables the student to distinguish chance or accidental variations from significant ones resulting from change in the material or technique, thus lessening dependence on random criteria practice.

iii) It offers simple criteria for delimiting types.

The so-called "simple" sherds can theoretically offer three main properties ⁽³²⁾. These are the thickness of the ware, the colour and the structure. As the thickness of a clay vessel varies according to the part of the vessel to which it belongs it cannot be a useful criterion, although Gardin took these variations into account and chose a constant reference point ⁽³³⁾. Nevertheless, with regard to fragments the problem is amplified as a precise reference point cannot be selected. The same applies to glass. The thickness of the fragment depends on the part of the vessel to which it belongs. Thickness can therefore be discounted.

The question of colour can also be passed over. It is well known that two pottery sherds from the same vessel can be seen to have different colours due to the action of different chemicals in the soil. Other factors such as firing temperature and presence or absence of reducing conditions also add to this. Glass is even more susceptible, for example although a vessel may be a particular shade of blue and can be classified accurately using an international colour code, the shade of blue is not consistent throughout the vessel. The thicker the wall of the glass, the deeper the colour. Certain types of glass are also very susceptible to weathering within the earth and a true colour is consequently difficult to establish.

As far as the structure of the fragments is concerned, the possibilities are more optimistic. The physical composition of the fragment should differ slightly from vessel to vessel. This is certainly true for pottery where the type of sand or gravel can provide a wide variety of information. This can be used as an element for recording, besides exhibiting features that render possible a study of origin. It may even provide information regarding the function of the particular vessels concerned. Comparisons between natural material and the material in the vessel can also be important. For example Stjernquist discovered that the settlement site known as Hötofta 18 in Scania, Sweden contained pottery made from clay which for some special reason had been deliberately selected from a deep layer (34). Other interesting factors arise. Soudsky in a further study of this methodology employed temper as an element in his grouping and assumed that variations in quality had a chronological significance (35). Pottery has a functional difference in structure which can be determined by technical examination. Certain vessels were purpose-built to fulfil certain needs, notably cooking and were thus manufactured to withstand heat. Glass, on the other hand, can offer no such obvious differences. Whereas pottery can offer temper as a valid grouping factor, glass can offer nothing comparable. Whether any of these fragments can be grouped depends to a large extent on the possibilities of extracting the relevant information. I have listed below the properties of glass fragments together with the usefulness for archaeological purposes of each.

<u>Property</u>		<u>Usefulness</u>
Thickness	-	None
Colour	-	None (apart from basic differentiation of vessel fragments with extreme colours).
Structure	-	i) an element for recording. ii) a possible source of origin. iii) functional difference (if any).

A typological approach

If a consistent method is to be applied to glass studies then it must be one which can successfully use all the material whether that material consists of complete or fragmentary items. A typological method was applied by Müller who stressed that in such an approach groupings should be made in terms of positive similarity rather than of dissimilarity (36). Malmer who accepts this adds that the typological descriptions on which the list of comparable attributes is to be based must not be discussed in terms of general attributes (37). By following this we avoid expressions such as "pear-shaped", "almost round" and "unusually large" which have no exact descriptive meaning. Correct terms of description are only relevant if they reflect attributes of an artefact which have avoided accidental change. Several of the current works on methodology rest on the assumption that there was no change in the character of the artefact between the time of production and the time of discovery. Articles which underwent changes between these periods cannot be compared with complete articles which bear unchanged attributes for in the former instance the attributes noticed

by the archaeologist may not have been relevant at the time of manufacture. Because fragments exist, whether in forms mutilated by cremation or natural conditions they still represent objective pieces of evidence, or in Clarke's words "fragments of solidified and preserved hominid behaviour patterns" (38). We are at liberty to discuss and compare full and complete items in terms of attributes such as the decorative, material, proportional, technical and form elements, because with the exception of the material all these are visual or can be measured by visual means (39). Each methodologist has his own set of elements for descriptive purposes. Clarke for example draws up artefact attributes which vary under the five main headings of material, shape, size, detail and location of detail elements (40). All but the material are visible and can be either drawn or metered. When these visual attributes are lacking, all or in part, as on the case of fragments, then it no longer becomes valid to use them as universal criteria for all conditions of glass remains. It is left to the task of the archaeologist to determine what he can from the fragmentary remains. Rarely can the full range of attributes be used in that determination. It could be said that the probability of gaining useful information from an item decreases with the deterioration of size and condition of that item. Thus the corpus of unrecognisable glass remains which have been virtually ignored in the majority of publications written in the methodological convention of the last fifty years seems almost certain to be ignored again under the new concepts of methodology. As long as criteria for comparison are based upon visible attributes the situation will remain unchanged. The initial

manufacture of the artefact is only directly related to these attributes as long as the artefact survives intact (41).

To attempt to define a strict boundary by which fragments can be judged as being of typological significance is a practical impossibility. We could perhaps count a certain number of attributes which the fragment might offer but this would reduce any series of complete vessels to a situation in which typological analysis would be based on only two or three criteria, thus rendering a general rather than specific description. By this certain attributes would be delimited, and fragments lacking the basic number of minimal attributes would still be ignored. Clarke also perceived this problem, and for artefacts which were imperfect or damaged in such a way that an attribute was removed he considered them as being in a state of "no comparison" for that character (42).

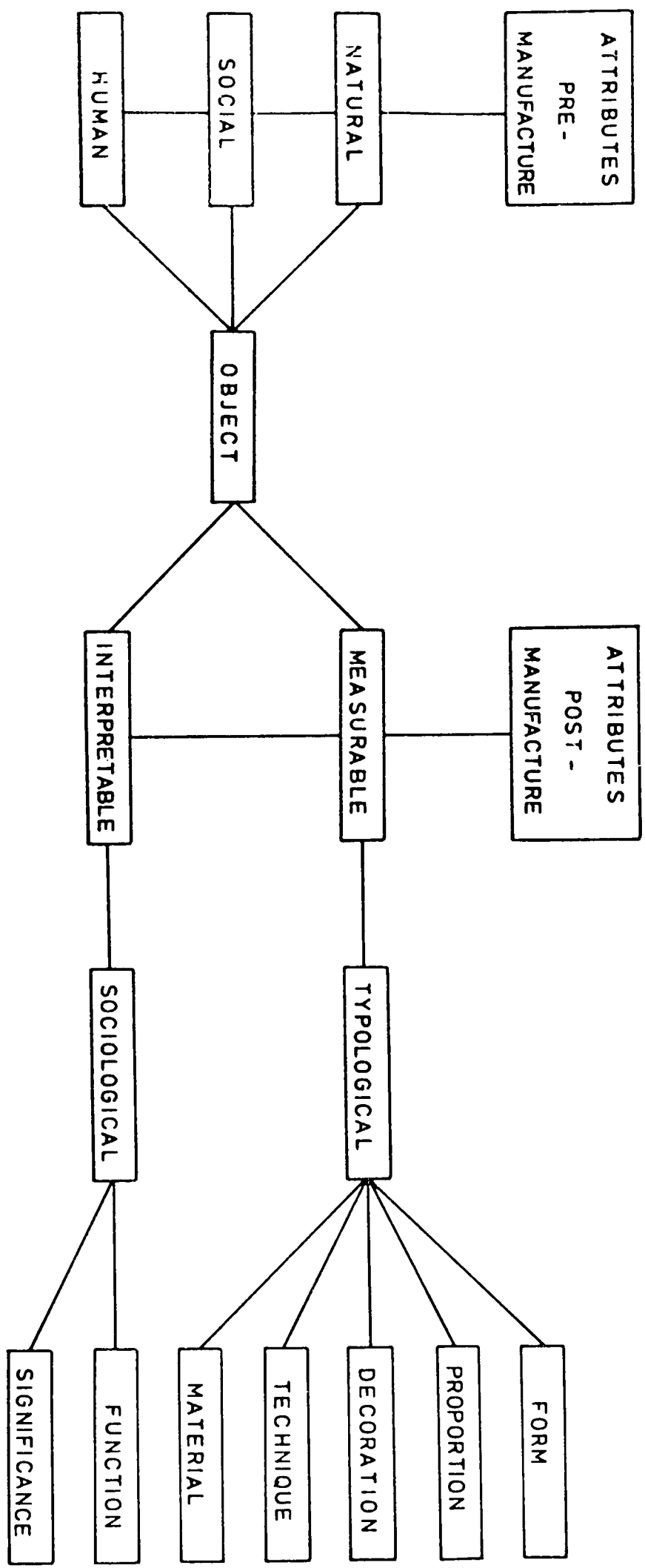
A further reason for the difficulty of the primary methodological approach is possibly unique to glass. Glass vessels may contain characteristics of form which may or may not be intentional and which in certain instances (for example with blown vessels) might produce a batch of vessels out of which no two would be exactly the same, depending on the skill of the glass master. Certain stages in the production of the vessel particularly those vulnerable to freaks of the manufacturing process can all have an effect on the final item. The main variation factors can be listed as follows:

- (1) Natural phenomena (i.e. impurity in the raw material).
- (2) Manufacturing variation (i.e. inefficient heating and cooling processes).

(3) Human error (i.e. manipulation).

Human activity can be reflected as a grouping factor in several instances. For example a behavioural attribute can be produced as much by a careful selection of raw material as by direct human alteration. Every attribute is representative of some action, whether those attributes are decorative or material. In the same way that each decorative mark on the surface of a pottery vessel is relevant, so each stage of the glass manufacturing process is also relevant. Each addition of chemical ingredient for whatever the purpose or each stage of cooling, re-heating or annealing can be considered an attribute. Each glass vessel requires a repeated sequence of actions both chemically and physically for its production. When the complete vessel is examined later in time certain of these attributes can be perceived by either visual or technical means. Other attributes such as the decorative and the form are more easily noticed while those governed by social and cultural factors are almost impossible to ascertain. A general system for this is outlined graphically in fig 4. This shows the manner in which the attributes occur. In the first instance a complex network is formed which combines natural, social and human factors. These can include the nature of the raw material, the needs of the society concerned and the choice of material and decoration respectively. The vessel is formed as a direct result of all three. From this point on the vessel is traded, sold and put into service. When it is eventually discovered centuries later and examined the attributes which constitute the object can be divided into two parts, the typological (which is measurable) and the

FIG 4.



sociological (which can only be interpreted). In the former group we can determine and measure the form, proportion and decoration of the vessel together with the technique used to make it and the material used in its production. In the latter, by taking into account other archaeological and historical evidence we can interpret its function and significance and subsequently formulate theories regarding trade and economy. The actual number of attributes per complete item is infinite but those available to the archaeologist are small in number. Every artefact contains an infinite number of attributes or variables and therefore an infinite number of possible systems networking these variables (43). The problem lies in defining a system which although relevant at the time of the manufacture of the vessel may not appear relevant today in an alien cultural environment.

Because the human element is so strong in the manufacturing process of glass, and because the process is so complex we can presume slight variations in material and form within standard types even from the same workshop. Consequently we can imagine an even greater variation in instances of copying by other workshops. We must therefore take care not to confuse development and variation of decoration with accidental variation caused by the reasons outlined above. This can easily be illustrated if we consider the traditional approaches regarding the vessel-type designated "claw-beaker". This vessel is usually discussed with regard to a development centred on the size and position of the claw itself, and its relation to the body of the vessel (44). This

would be more acceptable if all the vessels under consideration were complete, for there are then other criteria to be examined apart from those directly associated with the claw. In fragmentary form, however, individual claws can be discussed with little accuracy, especially considering the physical difficulties in producing this particular vessel in which the claws themselves are usually hollow and are formed individually. Fragments from such a vessel were discovered from Borre, Vestfold (305) in a burial assigned to the ninth century ⁽⁴⁵⁾. The complete type to which these fragments were related was one found in England and dated several centuries earlier.

The closer one examines the problems of typological analysis of this type of material the more it becomes apparent that an initial chronological rather than typological approach is preferable. Both the chronological and typological systems of primary approach have faults and neither are completely satisfactory. The chronological could include all the material (assuming that it lay in a datable context) regardless of condition and this would require the use of associated finds. The main problem here is that not all the material is closely datable although works by Nerman and others have provided a useful corpus of associated dated finds. A method devised for overcoming this dating difficulty by using frequency distribution is used below in chapter 6. The typological approach disregards the fragments in conventional method but fully documents complete items. At this stage a logical conclusion would be to take the primary chronological approach to embrace the majority of the material followed by a

secondary typological approach. This would be fashioned in the manner devised by Ekholm but without the inconsistency of criteria. The problem of the fragments can only be overcome by using a system whereby characteristics of the fragments in their existing conditions can be observed. This must be carried out using methods which are not reliant upon visible characteristics and which could be used regardless of any physical change in the fragments. The following requirements are needed:

- (i) A definition of types determined by non-visual characteristics.
- (ii) A method not dependant upon factors of culture or time difference between the person who made the item and the person who examines it later in time.
- (iii) A method which disregards any physical change in the item between the time of manufacture and the time of discovery.

A glass vessel has certain information to offer and methods complying to the three conditions above can illuminate the integrated actions required for the manufacture of that vessel. In a small way this can reflect the scope of the culture that produced it. Fortunately glass is normally a chemically homogenous product and the very nature of its structure allows elementary classification into simple types defined chemically. This can be illustrated by assuming that these different chemical groupings are governed by three main factors.

- i) The composition of the raw material (i.e. trace elements).
- ii) The chemical variety of the glass type (i.e. soda-lime)
- iii) The additives for colouring or discolouring employed by the manufacturer.

The composition of the raw material is presumably based on local supply, and therefore material used in the manufacture will reflect characteristics of that locality. We may never be able to locate the exact area, but we can group together glasses of similar chemical composition. Local material which is naturally high in a certain trace element or which contains a characteristic impurity will show this in the analysis of a vessel or fragment made in that region. It would therefore seem possible to relate glass vessels and fragments by means of these elements. Any similarities will remain constant despite any change in the condition of the glass itself, even by cremation.

The basic varieties of glass are usually apparent after a preliminary analysis and are clearly distinct from each other. We can for example distinguish clearly between the early glass with high soda-lime content, and that of the "weald" glass variety simply because the oxides of their chemical elements have noticeably different percentages in each (46).

The additives for colouring or decolouring employed by the manufacturer are also useful guides especially in relation to early methods of manufacture. It is possible that in the early history of glass-making the advance of chemical and technical knowledge could be followed

to some extent in the use and variation of certain additives. Smith and Sayre have demonstrated a chronological significance in the use of antimony and manganese as decolourants (47). Arwidsson offered certain arguments regarding the significance of lead in the lobed beakers from Valsgårde, Uppland, Sweden (48). Work of this nature was also carried out to determine the exact method of manufacture and the elements used in the production of the vessels which exhibited the "Lycurgus Effect", showing different colours in reflected and transmitted light (49).

Physical analysis such as this could provide a method of utilising the numerous fragments which are not susceptible to any other form of typological analysis. The idea was used in a limited capacity by Chambon and Arbman in their study of a Belgian glass centre in an effort to correlate certain problems of continuity (50). The concept has been used widely elsewhere and relevant examples are given below in a discussion of the advantages of physical analysis in chapters 7 and 8. In Scandinavia the only major work to have been produced using this type of analysis concerned metalwork from the Early Bronze Age and was devised to classify artefacts in a similar manner (51).

Only an accurate quantitative analysis is of any value for the determination of regional and chronological differences. It must reveal in what respects the specimens conform to or depart from the characteristics of various recognisable groups of glass in antiquity. Several methods are available for this. The methods eventually selected here, electron beam micro-probe analysis and neutron activation analysis, can be used to quantify major elements and trace elements respectively. Both

are essentially destructive in that they require a sample from the vessel but the advantages of accurate quantitative results make the sacrifice worthwhile. Detailed discussion of both methods appears in the chapters devoted to the physical analysis of the material.

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CHAPTER FIVE - TYPOLOGICAL ELEMENTS

Having in theory now found a solution to the problem of fragments, the next stage is to devise a typological system suitable for the material available. The problem now is to establish which descriptive criteria are to be used and in which order they should be organised so that complete and fragmentary items alike can be used to the maximum extent.

Brew among others has shown that grouping systems for such an analysis are by their very nature subjectively formed ⁽¹⁾. Any system of classification devised by the archaeologist places objects or apparent attributes of objects into particular groupings which the archaeologist himself selects. Brew argues that no typological system is actually inherent in the material under study. Any "a priori" system of typology assumes some traceable network of connections between the series of artefacts and the social environment in which they were made. Such a connection is difficult to appreciate because of the vast time and culture difference between our society and the society that made the artefacts. Some of the typologies can be related to a significant degree such as those pertaining to function. Others such as decoration are less easy to assign. I would maintain that for artefacts which had an obvious function, and glass vessels are clearly included here, there are limited "a priori" typologies. If an object is used for a specific purpose then it is manufactured with that end in mind.

The method adopted here involves the breakdown of each item into

eleven different typological entities each containing a series of variables denoted by a numerical code. By this each vessel or fragment can be defined by a series of numbers and made available to computer facilities for storage and sorting (2).

The first stage must take into consideration the functional form elements. In common with all stages of the typology the groupings must be comprehensive to include all known types of form. This ensures that all the material available can be included and that any later material can be added. Most groupings will by necessity contain a category headed "other". The comprehensive nature of the main groupings should ensure that the numbers in that category are kept to a minimum. The numbers used in the definitions below are those which appear in the typological lists and on the computer tape. The presence of the zero digit (0) signifies that a particular element was not available often for the reason that the fragment was too small or mutilated to supply the necessary information. The variables in each grouping are organised where possible in alphabetical order.

The first stage which relates to function type is composed as follows:

<u>Column</u>	<u>Code</u>	<u>Definition</u>
A.	(1)	Fragmentary
	(2)	Beaker
	(3)	Bowl
	(4)	Cup
	(5)	Flask/Bottle
	(6)	Jar
	(7)	Other.

The second stage relates to proportional characteristics defined here in terms of the ratio between the height of the vessel and the diameter of the rim. This is associated with the function type above and is only relevant as an extra element in the discussion of complete objects. This is composed as follows:

<u>Column</u>	<u>Code</u>	<u>Definition</u>
B.	(1)	Less than 0,50
	(2)	0,51 to 1,00
	(3)	1,01 to 1,50
	(4)	1,51 to 2,00
	(5)	2,01 to 2,50
	(6)	Greater than 2,50.

The third stage relates to the profile of the body of the vessel: a descriptive element which is often applicable to fragmentary vessels as well as complete vessels in cases where a large proportion of the vessel still survives. This is composed under the following headings:

<u>Column</u>	<u>Code</u>	<u>Definition</u>
C.	(1)	Conical
	(2)	Funnel
	(3)	Globular/bulbous
	(4)	Horn-shaped
	(5)	Round
	(6)	Semi-spherical
	(7)	Straight
	(8)	Other.

The next stage is concerned with the base of the vessel and relates to the absence or presence of foot. With vessels such as the drinking horn I am assuming that the base end of the vessel is the non-open end. It does not necessarily signify the standing area.

This is composed as follows:

<u>Column</u>	<u>Code</u>	<u>Definition</u>
D.	(1)	Flat
	(2)	Foot
	(3)	Foot-ring
	(4)	Mouthpiece (horn)
	(5)	Ribbed feet
	(6)	Rounded base
	(7)	Other.

The next two categories represent the rim form and the rim direction respectively. These are organised so that any known combination of the two can be denoted without using an unwieldy terminology. These are listed below:

<u>Column</u>	<u>Code</u>	<u>Definition</u>
E.	(1)	Cut/Broken
	(2)	Flattened
	(3)	Folded
	(4)	Rounded
	(5)	Rounded and thickened
	(6)	Other.

<u>Column</u>	<u>Code</u>	<u>Definition</u>
F.	(1)	In-turned
	(2)	Out-turned
	(3)	Straight.

The final category concerned with major features has by necessity to be headed "Other features". This is essentially a concluding category containing basic elements of form and decoration which are not otherwise represented. It also allows scope for unusual or unique vessels to be sorted by means of their special features.

These are listed as follows:

<u>Column</u>	<u>Code</u>	<u>Definition</u>
G.	(1)	None
	(2)	Boss
	(3)	Claw
	(4)	Handle
	(5)	Inscription
	(6)	Prunt
	(7)	Stem
	(8)	Other.

The next three categories are concerned with the decorative elements of the vessels or fragments and are organised in such a way that even the smallest trace of decoration on a fragment can be described in one of the categories. This means that no decorative element need be ignored entirely due to size or mutilation of fragment. The first decorative category relates to the technique of decoration.

In this category decoration can always be used as a descriptive element even although the actual form of the decoration may not be fully available. The techniques can be listed as follows:

<u>Column</u>	<u>Code</u>	<u>Definition</u>
H.	(1)	None
	(2)	Applied
	(3)	Filigree
	(4)	Ground/Cut/Incised
	(5)	Marvered
	(6)	Moulded
	(7)	Painted
	(8)	2 in combination
	(9)	Other.

Another aspect of decoration which may be recorded from fragmentary evidence is the orientation of the field of decoration, although not usually to the extent of the category above. The terminology used relates to the horizontal or vertical axes of the vessels concerned. Here "horizontal" is defined as being in the same plane as the line of the rim and "vertical" is defined as being in the same plane as a line drawn from the centre of the rim to the centre of the base of the vessel. In a vessel such as a drinking horn the descriptions relate to an imaginary linear vessel of conical rather than horn form, thus any decoration along the curvature from the rim to the base (mouthpiece) is defined as being vertical and any decoration set around the curvature is defined as being horizontal. The categories can be listed as follows:

<u>Column</u>	<u>Code</u>	<u>Definition</u>
I.	(1)	None
	(2)	Horizontal
	(3)	Vertical
	(4)	Both Horizontal and Vertical
	(5)	Other
	(6)	Other in combination with 2 and 3.

The final decorative category is concerned with the actual form of the decoration itself within its field of orientation. The two most common forms are linear and faceted decoration, the latter being principally concerned with the use of the oval or the circle as decorative forms. These are as follows:

<u>Column</u>	<u>Code</u>	<u>Definition</u>
J.	(1)	None
	(2)	Faceted
	(3)	Linear
	(4)	Both Faceted and Linear
	(5)	Naturalistic
	(6)	Other.

The category remaining is concerned with the differentiation of colour. In certain instances colour is important especially as a decorative element on an individual vessel. One can suitably record instances in which the decoration is of a different colour from the vessel on which it is used. Colour can be used as a recording element in the following categories:

<u>Column</u>	<u>Code</u>	<u>Definition</u>
K.	(1)	None
	(2)	Decoration same colour as vessel
	(3)	Decoration different colour from vessel
	(4)	Both 2 and 3.
	(5)	Vessel itself more than one colour
	(6)	Uberfang (cased) vessels.

The final attributes available for comparison are derived from the material elements. Here one can use the chemical groupings discussed earlier for both complete and fragmentary vessels. Only a small part of the corpus was subjected to this type of examination and the material elements are not included in these tables. The total order of typology can therefore be summarised in the following manner:

- A) Function Type (seven variables)
- B) Proportional Characteristics (six variables)
- C) Body Profile (eight variables)
- D) Base Elements (seven variables)
- E) Rim Form (six variables)
- F) Rim Direction (three variables)
- G) Other features (eight variables)
- H) Technique of Decoration (nine variables)
- I) Orientation of Field of Decroation (six variables)
- J) Form of Decoration (six variables)
- K) Differentiation of Colour (six variables).

Each individual vessel or fragment can easily be defined by a series of numbers. It should be remembered that these numbers in many instances refer to an obvious physical characteristic defined only in general terms in order to facilitate the recording of features. Although, for example, two vessels may have the same numerical coding for decorative features, it does not necessarily signify that they are identical, only that the decorative features have certain obvious similarities. A complete list of all vessels and their numerical codes is written below. The material elements are not included for the reason that they only relate to approximately ten per cent of the corpus. The methods and results of the physical analyses are written in chapter 7 and chapter 8.

In order to utilise computer facilities to the maximum possible extent two more columns were added to the typological data lists. The first relates to the archaeological context of the discovery. These are listed as follows:

<u>Column</u>	<u>Code</u>	<u>Definition</u>
L.	(1)	Cremation burial
	(2)	Inhumation burial
	(3)	Occupation layer
	(4)	Unknown or stray.

The second column is chronological and can be used as a check against typological progression. This now means that the typology, archaeological context and chronology of each individual fragment or vessel can be expressed numerically in a form appropriate to computer sorting, clustering and storage. The chronological column is by necessity more

complex than the other categories. It relates to the date of the burial or occupation and not necessarily to the actual date of the vessel. It is assumed that major discrepancies will comprise only a small percentage of the corpus and consequently that the error will be minimal. In instances where the dating appears between or close to the limits of the various chronological divisions used the glass is placed in the earlier period to allow for manufacture, transport and time for usage. Ten periods are used, with the final digit zero (0) representing both undated samples and samples only dated between the ultimate periods of chronology used (i.e. the Roman and Viking periods). The periods are listed below:

M) Chronological Period

Roman Iron Age (AD 50-400)	- 1)			
)	5		
Migration Period (AD 400-550/600)	- 2))	8	
)	6)	0
Vendel Period (AD 550/600-800)	- 3))	9	
)	7		
Viking Period (AD 800-1050)	- 4)			

The complete typological lists in numerical code are as follows:

<u>Catalogue Number</u>	<u>Typological Code</u>
	A B C D E F G H I J K L M
001	1 0 0 0 0 0 0 2 0 3 2 1 1
002	1 0 0 0 0 0 0 2 0 3 3 1 1
003	1 0 0 2 4 2 0 2 4 3 2 1 1
004	1 0 0 0 0 0 4 6 0 0 2 1 1
005	1 0 0 0 0 0 0 2 0 3 3 1 1
006	1 0 0 5 0 0 0 1 1 1 1 1 1
007	1 0 2 6 0 0 0 2 0 3 2 1 1
008	1 0 0 0 0 0 0 4 0 0 2 1 2
009	1 0 0 0 0 0 0 0 0 0 0 1 1
010	1 0 0 0 0 0 0 2 0 3 2 3 2
011	1 0 0 0 0 0 0 2 0 3 2 3 2
012	1 0 0 0 0 0 0 0 0 0 0 3 2
013	1 0 0 0 0 0 0 7 5 5 3 1 1
014	1 0 0 0 0 0 0 0 0 0 0 1 1
015	4 2 7 5 4 3 1 1 1 1 1 2 1
016	1 0 0 0 0 0 0 0 0 0 0 1 1
017	1 0 0 3 4 2 0 0 0 0 0 1 1
018	4 0 6 3 4 2 1 4 5 3 2 4 0
019	2 4 1 2 5 3 1 2 4 3 2 2 2
020	4 2 5 1 4 3 1 4 2 4 2 2 1

<u>Catalogue Number</u>	<u>Typological Code</u>
	A B C D E F G H I J K L M
021	1 0 0 0 0 0 0 0 0 0 0 1 1
022	6 3 3 3 4 3 1 1 1 1 5 2 1
023	4 0 7 5 4 3 1 1 1 1 1 4 0
024	1 0 0 0 0 0 0 4 0 3 2 3 2
025	1 0 0 0 0 0 0 0 0 0 0 1 1
026	3 0 5 1 0 0 0 6 3 2 2 2 1
027	4 2 7 3 4 3 1 1 1 1 1 2 1
028	4 2 7 3 4 3 1 1 1 1 1 2 1
029	4 2 7 3 4 3 1 1 1 1 1 2 1
030	2 0 4 4 0 0 0 2 3 3 2 3 2
031	2 0 4 4 0 0 0 2 3 3 2 3 2
032	2 0 4 4 0 0 0 2 3 3 2 3 2
033	1 0 0 0 0 0 3 0 0 0 0 3 2
034	2 6 1 6 4 3 1 2 4 3 3 3 2
035	2 0 2 0 0 0 0 0 0 0 0 2 4
036	6 3 3 1 5 2 1 8 4 3 3 2 2
037	1 0 1 0 0 0 0 2 3 3 2 3 2
038	3 1 5 1 4 3 1 6 5 6 5 2 1
039	3 1 5 1 4 3 1 6 5 6 5 2 1
040	1 0 0 0 0 0 0 0 0 0 0 3 1

<u>Catalogue Number</u>	<u>Typological Code</u>
	A B C D E F G H I J K L M
041	4 0 7 5 0 0 0 0 0 0 0 2 1
042	2 0 1 6 0 0 1 2 4 3 2 2 2
043	3 2 7 1 1 2 1 4 4 4 2 2 1
044	1 0 0 0 4 2 0 0 0 0 0 2 1
045	3 2 8 6 4 2 1 2 2 3 2 2 2
046	5 6 7 1 2 2 4 1 1 1 1 2 1
047	3 2 6 6 1 2 1 4 4 4 2 2 1
048	3 2 6 6 1 2 1 4 4 4 2 2 1
049	3 2 6 6 1 2 1 4 4 4 2 2 1
050	4 0 7 3 4 3 1 1 1 1 1 2 1
051	2 4 1 2 5 3 1 2 6 3 3 2 1
052	2 3 5 1 1 3 1 4 2 4 6 2 2
053	4 0 7 3 4 3 1 1 1 1 1 2 1
054	2 5 7 2 4 2 7 2 6 3 3 2 1
055	2 6 4 4 4 2 1 2 4 3 2 2 1
056	2 6 4 4 2 2 1 9 3 6 2 2 1
057	4 2 7 3 4 3 1 7 5 5 3 2 1
058	1 0 0 0 0 0 0 0 0 0 0 2 4
059	2 3 7 6 1 2 1 4 2 4 2 2 1
060	1 0 0 0 0 0 0 0 0 0 0 2 1

<u>Catalogue Number</u>	<u>Typological Code</u>
	A B C D E F G H I J K L M
061	2 3 7 6 1 2 1 4 2 4 2 2 1
062	1 0 0 0 0 0 0 4 0 2 2 2 1
063	1 0 0 0 0 0 0 4 0 2 2 2 1
064	4 2 7 1 1 2 2 1 4 4 2 2 1
065	3 2 6 6 4 2 1 6 4 6 5 2 1
066	3 2 6 6 4 2 1 6 4 6 5 2 1
067	2 4 1 2 1 3 7 4 4 4 2 2 1
068	2 0 0 0 1 3 0 4 0 4 2 2 1
069	1 0 0 0 0 0 0 2 0 3 2 2 4
070	2 3 7 1 4 2 1 4 4 4 2 2 1
071	2 4 1 2 4 2 1 2 6 3 2 2 2
072	2 4 1 2 5 3 1 2 6 3 3 2 1
073	2 4 1 2 5 3 1 2 6 3 3 2 1
074	2 4 4 4 4 2 1 2 4 3 2 2 1
075	4 2 6 6 1 3 1 4 2 4 2 2 1
076	4 2 6 6 1 2 1 1 1 1 1 2 1
077	1 0 0 0 0 0 0 0 0 0 0 1 1
078	4 2 7 5 5 3 1 1 1 1 1 2 1
079	2 3 7 6 1 2 1 4 2 4 2 2 1
080	1 0 0 0 0 0 0 0 0 0 0 1 1

<u>Catalogue Number</u>	<u>Typological Code</u>
	A B C D E F G H I J K L M
081	1 0 0 0 0 0 0 2 0 3 3 1 1
082	1 0 0 0 0 0 0 0 0 0 0 1 1
083	1 0 0 0 0 0 0 2 0 3 3 1 1
084	1 0 0 0 0 0 0 4 0 3 2 1 1
085	1 0 0 0 0 0 0 2 0 3 3 1 1
086	1 0 0 0 0 0 0 0 0 0 0 1 1
087	1 0 0 2 0 0 0 0 0 0 0 1 1
088	1 0 0 0 0 0 0 0 0 0 0 1 1
089	1 0 0 0 0 0 0 0 0 0 0 1 1
090	1 0 0 0 0 0 0 0 0 0 0 1 1
091	1 0 0 0 0 0 0 0 0 0 0 1 1
092	1 0 0 0 0 0 0 2 0 3 2 1 1
093	1 0 0 0 0 0 0 0 0 0 0 1 1
094	1 0 0 0 0 0 0 2 0 3 3 1 1
095	1 0 0 0 0 0 0 0 0 0 0 1 1
096	1 0 0 0 0 0 0 0 0 0 0 1 1
097	1 0 0 0 0 0 0 2 0 3 2 1 1
098	1 0 0 0 0 0 0 4 0 2 2 1 1
099	1 0 0 0 5 1 0 2 2 3 2 1 1
100	1 0 0 0 0 0 0 0 0 0 0 1 1

<u>Catalogue Number</u>	<u>Typological Code</u>
	A B C D E F G H I J K L M
101	1 0 0 0 0 0 0 0 0 0 0 1 1
102	1 0 0 0 5 3 0 4 0 2 2 1 1
103	1 0 0 0 0 0 0 0 0 0 0 1 1
104	1 0 0 0 0 0 0 0 0 0 0 1 1
105	1 0 0 0 5 3 0 0 0 0 0 1 1
106	4 2 7 6 5 2 1 2 2 3 2 1 1
107	1 0 0 0 0 0 0 0 0 0 0 1 1
108	1 0 0 0 0 0 0 4 0 2 2 1 1
109	1 0 0 0 0 0 0 0 0 0 0 1 1
110	1 0 0 0 0 0 0 0 0 0 0 1 1
111	1 0 0 0 0 0 0 4 0 2 2 1 1
112	1 0 0 0 0 0 0 0 0 0 0 1 1
113	1 0 0 0 0 0 0 0 0 0 0 1 1
114	1 0 0 0 0 0 0 2 0 3 3 1 1
115	1 0 7 0 4 3 1 7 5 5 3 1 1
116	1 0 0 0 0 0 0 4 0 2 2 1 1
117	1 0 0 0 0 0 0 0 0 0 0 1 1
118	1 0 0 0 0 0 0 2 0 3 3 1 1
119	1 0 0 0 0 0 0 0 0 0 0 1 1
120	1 0 0 0 0 0 0 0 0 0 0 1 1

<u>Catalogue Number</u>	<u>Typological Code</u>
	A B C D E F G H I J K L M
121	1 0 0 0 0 0 0 0 0 0 0 1 1
122	4 2 7 1 5 2 1 1 1 1 1 1 1
123	1 0 0 0 0 0 0 2 0 3 3 1 1
124	1 0 0 0 0 0 0 2 0 3 3 1 1
125	1 0 0 0 0 0 0 0 0 0 0 1 1
126	1 0 0 0 0 0 0 0 0 0 0 1 1
127	1 0 0 0 0 0 0 0 0 0 0 1 1
128	1 0 0 0 0 0 0 4 0 2 2 1 1
129	1 0 0 0 0 0 0 0 0 0 0 1 1
130	1 0 0 0 0 0 0 0 0 0 0 1 1
131	1 0 0 0 0 0 0 0 0 0 0 1 1
132	1 0 0 0 0 0 0 0 0 0 0 1 1
133	1 0 0 0 0 0 0 0 0 0 0 1 1
134	1 0 0 0 0 0 0 0 0 0 0 1 1
135	1 0 0 0 0 0 0 0 0 0 0 1 1
136	1 0 0 0 0 0 0 4 0 2 2 1 1
137	1 0 0 0 0 0 0 0 0 0 0 1 1
138	1 0 0 0 0 0 0 0 0 0 0 1 1
139	4 0 7 3 4 3 1 1 1 1 1 2 1
140	6 5 8 3 5 2 1 1 1 1 1 2 1

<u>Catalogue Number</u>	<u>Typological Code</u>
	A B C D E F G H I J K L M
141	4 2 7 3 4 3 1 7 5 5 3 2 1
142	4 2 7 3 4 3 1 7 5 5 3 2 1
143	2 4 1 2 4 2 1 2 6 3 3 2 1
144	2 4 1 2 4 2 1 2 6 3 3 2 1
145	2 4 1 6 1 2 1 4 2 4 2 2 1
146	1 0 0 0 0 0 0 0 0 0 0 1 1
147	1 0 0 0 0 0 0 4 0 2 2 2 1
148	1 0 0 0 0 0 0 0 0 0 0 1 1
149	1 0 0 0 0 0 0 7 5 5 3 1 1
150	2 4 1 2 5 2 1 2 6 3 3 2 1
151	2 4 1 2 5 2 1 2 4 3 2 2 1
152	1 0 0 0 0 0 0 0 0 0 0 1 1
153	1 0 0 0 0 0 0 2 0 3 2 2 1
154	1 0 0 0 0 0 0 2 0 3 2 2 1
155	1 0 0 0 0 0 0 0 0 0 0 1 1
156	4 2 6 6 1 3 1 4 2 2 2 2 1
157	4 2 6 6 1 3 1 4 2 2 2 2 1
158	4 2 5 1 4 2 1 4 2 2 2 2 1
159	2 6 4 4 2 2 1 9 3 3 2 2 1
160	2 3 1 2 1 2 1 4 2 4 2 2 1

<u>Catalogue Number</u>	<u>Typological Code</u>
	A B C D E F G H I J K L M
161	2 3 1 2 1 2 1 4 2 4 2 2 1
162	1 0 0 0 0 0 0 7 5 5 3 2 1
163	6 6 3 2 5 2 1 2 4 3 2 4 1
164	4 2 5 1 4 2 1 4 2 3 2 2 1
165	1 0 0 0 0 0 0 4 0 2 2 4 1
166	2 3 7 6 1 2 1 4 2 4 2 2 1
167	4 0 7 3 5 2 1 7 5 5 3 2 1
168	4 0 7 3 5 2 1 1 1 1 1 2 1
169	4 0 7 3 5 2 1 1 1 1 1 2 1
170	2 0 1 2 4 3 1 2 4 3 2 2 1
171	2 0 1 2 4 3 1 2 4 3 2 2 1
172	2 0 1 2 4 3 1 2 4 3 2 2 1
173	1 0 0 0 0 0 0 2 5 3 3 2 1
174	1 0 0 0 0 0 0 2 4 3 3 2 1
175	6 3 3 3 5 2 1 2 6 3 3 2 1
176	4 0 7 3 4 3 1 7 5 5 3 2 1
177	4 0 7 0 0 0 0 7 5 5 3 2 1
178	4 0 7 0 0 0 0 7 5 5 3 2 1
179	1 0 0 0 0 0 0 4 0 2 2 2 1
180	3 2 6 6 0 0 5 1 1 1 1 2 1

<u>Catalogue Number</u>	<u>Typological Code</u>
	A B C D E F G H I J K L M
181	4 2 5 1 1 3 1 4 2 4 2 2 1
182	2 3 7 1 1 2 1 4 4 2 2 2 1
183	7 0 8 7 1 3 1 1 1 1 1 2 1
184	4 2 7 5 5 2 1 1 1 1 1 2 1
185	1 0 0 0 0 0 0 0 0 0 0 2 1
186	2 3 1 2 1 2 5 4 4 4 5 4 1
187	1 0 5 1 0 0 1 6 3 3 2 2 1
188	4 0 5 1 1 2 1 1 1 1 1 2 1
189	4 2 5 6 4 2 6 2 2 3 2 2 1
190	2 3 7 6 1 2 1 4 2 4 2 2 1
191	1 0 0 0 0 0 0 2 0 3 2 1 3
192	1 0 0 0 0 0 0 2 3 3 2 3 2
193	1 0 0 0 0 0 0 4 0 2 2 1 2
194	1 0 0 0 0 0 0 2 0 3 3 3 1
195	
196	1 0 0 0 0 0 0 2 2 3 2 1 0
197	3 4 3 1 5 2 1 2 4 3 2 4 3
198	1 0 0 0 0 0 0 2 2 3 2 1 3
199	1 0 0 0 0 0 0 0 0 0 0 1 0
200	1 0 0 0 0 0 0 0 0 0 0 1 0

<u>Catalogue Number</u>	<u>Typological Code</u>
	A B C D E F G H I J K L M
201	1 0 0 0 0 0 0 0 0 0 0 1 0
202	1 0 0 0 5 3 0 2 4 3 2 3 2
203	1 0 0 0 3 2 0 0 0 0 0 3 2
204	1 0 0 0 0 0 0 2 4 3 2 3 2
205	1 0 0 0 0 0 0 0 0 0 0 1 1
206	1 0 0 0 0 0 0 0 0 0 0 1 2
207	1 0 0 0 0 0 0 2 5 3 2 1 2
208	2 4 1 2 4 2 1 2 4 3 2 2 2
209	1 0 0 0 0 0 0 2 0 3 2 1 3
210	1 0 0 0 0 0 0 2 0 3 2 1 3
211	1 0 0 0 5 2 0 0 0 0 0 1 3
212	1 0 0 1 0 0 0 0 0 0 0 1 3
213	1 0 0 0 4 3 0 2 4 3 2 1 3
214	2 4 1 2 4 2 1 2 4 3 2 2 2
215	1 0 0 0 0 0 0 0 0 0 0 1 0
216	6 3 3 1 4 2 1 9 3 3 2 2 3
217	2 6 1 2 5 3 3 2 2 3 2 4 3
218	1 0 0 0 0 0 0 0 0 0 0 1 2
219	1 0 0 0 0 0 0 0 0 0 0 1 1
220	1 0 0 0 0 0 0 0 0 0 0 1 2

<u>Catalogue Number</u>	<u>Typological Code</u>
	A B C D E F G H I J K L M
221	1 0 0 0 0 0 0 0 0 0 0 0 1 2
222	1 0 0 0 0 0 0 0 0 0 0 0 1 2
223	1 0 0 0 0 0 0 0 0 0 0 0 1 1
224	1 0 1 0 1 3 0 4 2 4 2 1 2
225	1 0 0 0 0 0 0 0 0 0 0 0 1 2
226	1 0 0 0 0 0 0 0 0 0 0 0 1 2
227	1 0 0 0 0 0 0 0 0 0 0 0 1 2
228	1 0 0 0 0 0 0 0 0 0 0 0 1 0
229	1 0 0 0 0 0 0 0 0 0 0 0 1 0
230	5 0 8 1 0 0 0 9 3 6 2 2 4
231	1 0 0 0 0 0 0 0 0 0 0 3 1 1
232	1 0 0 0 0 0 0 0 0 0 0 0 1 2
233	1 0 0 0 0 0 0 0 0 0 0 0 1 2
234	1 0 0 0 0 0 0 2 0 3 2 1 2
235	1 0 0 0 0 0 0 0 0 0 0 0 1 2
236	1 0 0 0 0 0 0 4 0 2 2 1 2
237	1 0 0 0 0 0 0 0 0 0 0 0 1 2
238	1 0 0 0 0 0 0 4 0 2 2 1 2
239	1 0 0 0 0 0 0 2 0 3 2 1 2
240	1 0 0 0 5 3 0 2 0 3 3 1 2

<u>Catalogue Number</u>	<u>Typological Code</u>
	A B C D E F G H I J K L M
241	1 0 0 0 0 0 0 0 0 0 0 1 2
242	1 0 0 0 0 0 0 2 0 3 2 1 0
243	1 0 0 6 0 0 0 0 0 0 0 1 3
244	1 0 0 0 0 0 0 0 0 0 0 1 3
245	1 0 0 0 0 0 6 2 0 3 2 1 3
246	1 0 0 0 0 0 0 0 0 0 0 1 3
247	1 0 0 0 0 0 0 2 0 3 2 1 3
248	1 0 0 0 0 0 0 2 0 3 2 1 3
249	1 0 0 0 0 0 0 4 0 2 2 1 1
250	1 0 0 0 0 0 0 2 0 3 2 1 3
251	1 0 0 0 0 0 0 2 3 3 2 1 3
252	1 0 0 0 0 0 3 0 0 0 0 1 2
253	2 5 1 2 4 2 1 2 4 3 2 2 2
254	1 0 0 0 0 0 0 2 4 3 2 1 2
255	1 0 0 0 0 0 0 0 0 0 0 1 1
256	1 0 0 0 0 0 0 2 2 3 2 2 3
257	4 2 1 6 3 2 1 1 1 1 1 2 3
258	1 0 0 0 0 0 0 0 0 0 0 2 2
259	2 4 1 2 2 3 1 2 6 3 2 2 3
260	1 0 0 0 0 0 0 0 0 0 0 2 2

<u>Catalogue Number</u>	<u>Typological Code</u>
	A B C D E F G H I J K L M
261	1 0 0 0 0 0 0 0 0 0 0 1 3
262	1 0 0 0 0 0 0 0 0 0 0 1 3
263	1 0 0 0 4 3 0 2 2 3 2 1 3
264	2 4 1 2 5 2 1 2 4 3 2 4 0
265	2 5 5 6 1 3 1 2 4 3 2 4 3
266	1 0 0 0 0 0 0 0 0 0 0 1 1
267	1 0 0 0 0 0 0 0 0 0 0 1 1
268	1 0 0 0 0 0 0 2 0 3 2 1 0
269	1 0 0 0 0 0 0 4 0 0 6 2 1
270	2 4 1 2 5 2 1 2 4 3 2 2 2
271	1 0 0 0 5 2 0 2 4 3 2 1 2
272	1 0 0 0 0 0 0 0 0 0 0 1 2
273	1 0 0 0 0 0 0 0 0 0 0 1 2
274	1 0 0 0 0 0 0 0 0 0 0 1 1
275	1 0 0 0 0 0 0 0 0 0 0 1 1
276	1 0 0 0 0 0 0 0 0 0 0 1 5
277	1 0 0 0 0 0 0 0 0 0 0 1 2
278	1 0 0 0 0 0 0 0 0 0 0 1 0
279	1 0 0 0 0 0 0 0 0 0 0 1 2
280	1 0 0 0 0 0 0 0 0 0 0 1 2

<u>Catalogue Number</u>	<u>Typological Code</u>
	A B C D E F G H I J K L M
281	2 0 1 2 0 0 3 2 2 3 2 2 3
282	2 4 1 2 1 3 1 4 6 4 2 2 1
283	1 0 0 0 0 0 0 0 0 0 6 1 2
284	1 0 0 0 0 0 0 0 0 0 0 1 3
285	1 0 0 0 0 0 0 0 0 0 0 1 3
286	1 0 0 0 0 0 0 0 0 0 0 1 3
287	1 0 0 0 0 0 0 2 0 3 2 1 3
288	1 0 0 0 0 0 0 4 0 3 2 1 3
289	1 0 0 0 0 0 0 0 0 0 0 1 3
290	1 0 0 0 0 0 0 0 0 0 0 1 3
291	1 0 0 0 0 0 0 0 0 0 0 1 3
292	3 0 3 1 0 0 0 2 4 3 2 4 3
293	3 3 3 1 4 2 1 2 4 3 2 4 3
294	1 0 0 0 0 0 0 4 0 3 2 2 1
295	1 0 0 0 0 0 0 2 4 3 2 2 2
296	1 0 0 0 0 0 0 0 0 0 0 2 2
297	1 0 0 0 0 0 0 0 0 0 0 2 1
298	1 0 0 0 0 0 0 0 0 0 0 1 2
299	1 0 0 0 0 0 0 0 0 0 0 1 3
300	1 0 0 0 0 0 0 0 0 0 0 1 3

<u>Catalogue Number</u>	<u>Typological Code</u>
	A B C D E F G H I J K L M
301	1 0 0 0 0 0 0 0 0 0 6 1 0
302	1 0 0 0 0 0 0 2 0 3 2 1 3
303	2 6 1 6 1 3 1 1 1 1 1 2 2
304	1 0 0 0 0 0 0 0 0 0 0 2 2
305	2 4 1 2 4 2 3 2 2 3 3 2 4
306	2 3 1 6 1 3 1 4 4 4 2 2 1
307	1 0 0 0 0 0 0 3 0 3 3 1 3
308	2 4 1 6 1 3 1 4 4 4 2 2 2
309	1 0 0 0 0 0 0 2 0 3 3 2 3
310	1 0 0 2 0 0 0 2 3 3 2 2 2
311	2 3 7 6 1 2 1 4 2 4 2 2 1
312	1 0 0 0 0 0 0 0 0 0 0 1 1
313	1 0 0 0 0 0 0 4 0 2 6 1 1
314	1 3 0 0 1 3 1 4 4 4 6 2 3
315	3 4 5 1 4 2 1 5 5 3 3 2 1
316	1 0 0 0 0 0 0 4 0 2 2 1 2
317	2 4 1 6 1 3 1 4 6 4 2 2 1
318	1 0 0 0 0 0 0 4 0 2 2 4 2
319	2 4 1 6 1 2 1 4 4 4 2 2 1
320	1 0 0 0 1 3 0 4 4 4 2 2 1

<u>Catalogue Number</u>	<u>Typological Code</u>
	A B C D E F G H I J K L M
321	1 0 0 0 0 0 0 4 0 2 2 1 1
322	1 0 0 0 0 0 0 4 0 2 2 1 2
323	1 0 0 0 0 0 0 4 0 2 2 1 2
324	2 3 1 6 1 3 1 4 2 4 2 2 1
325	1 0 2 0 5 3 0 0 0 0 0 1 4
326	1 0 0 0 0 0 0 4 0 2 2 2 1
327	2 3 1 2 1 3 1 4 4 4 2 1 2
328	2 0 1 2 5 2 1 2 4 3 2 2 2
329	2 3 1 2 2 2 1 4 4 4 2 2 2
330	2 3 1 2 2 2 1 4 4 4 2 2 2
331	3 1 5 1 1 3 2 2 4 4 3 2 2
332	1 0 0 0 0 0 0 0 0 0 0 4 4
333	1 0 0 0 0 0 0 4 0 2 2 1 2
334	6 3 3 1 5 2 1 3 4 3 3 2 4
335	6 4 3 1 5 2 1 1 1 1 1 2 4
336	4 0 6 6 1 3 1 4 2 4 2 1 1
337	2 3 7 6 4 3 1 4 2 4 2 2 1
338	2 0 4 0 1 2 4 2 4 3 2 2 2
339	1 0 0 0 4 1 0 0 0 0 5 3 7
440	1 0 0 0 4 1 0 0 0 0 0 3 7

<u>Catalogue Number</u>	<u>Typological Code</u>
	A B C D E F G H I J K L M
341	2 0 2 0 0 0 0 0 0 0 5 3 7
342	2 0 2 6 0 0 0 0 0 0 0 3 7
343	2 0 2 0 5 3 0 0 0 0 0 3 7
344	1 0 0 0 4 3 0 0 0 0 5 3 7
345	1 0 0 0 4 1 0 0 0 0 0 3 7
346	1 0 0 0 5 2 0 0 0 0 0 3 7
347	1 0 0 0 4 3 0 0 0 0 0 3 7
348	2 0 2 0 0 0 0 0 0 0 0 3 7
349	2 0 2 0 0 0 0 0 0 0 0 3 7
350	2 0 2 0 4 3 0 0 0 0 0 3 7
351	1 0 0 0 4 2 0 0 0 0 0 3 7
352	2 0 2 0 0 0 0 0 0 0 0 3 7
353	1 0 0 0 4 3 0 2 0 3 3 3 7
354	1 0 0 0 4 1 0 0 0 0 0 3 7
355	2 0 2 0 4 3 0 0 0 0 0 3 7
356	1 0 0 0 0 0 0 3 0 3 3 3 7
357	1 0 0 0 0 0 0 3 0 3 3 3 7
358	1 0 0 0 0 0 0 3 0 3 3 3 7
359	1 0 0 0 0 0 0 3 0 3 3 3 7
360	1 0 0 0 0 0 0 2 2 3 3 3 7

<u>Catalogue Number</u>	<u>Typological Code</u>
	A B C D E F G H I J K L M
361	1 0 0 0 0 0 0 2 2 3 3 3 7
362	1 0 0 0 4 3 0 2 2 3 3 3 7
363	1 0 0 0 0 0 0 2 2 3 3 3 7
364	1 0 0 0 4 1 0 5 2 3 3 3 7
365	1 0 0 0 3 2 0 2 2 3 3 3 7
366	1 0 0 0 0 0 0 2 0 3 3 3 7
367	1 0 0 0 0 0 0 2 2 3 3 3 7
368	1 0 0 0 0 0 3 0 0 0 0 3 7
369	1 0 0 0 0 0 0 5 2 3 3 3 7
370	1 0 0 0 0 0 0 2 2 3 3 3 7
371	1 0 0 1 0 0 0 0 0 0 0 3 7
372	1 0 0 6 0 0 0 0 0 0 0 3 7
373	1 0 0 0 0 0 0 0 0 0 0 3 7
374	1 0 0 0 0 0 0 5 0 3 3 3 7
375	1 0 0 0 0 0 0 2 0 3 3 3 7
376	1 0 0 0 0 0 0 0 0 0 0 3 7
377	1 0 0 0 0 0 0 0 0 0 0 3 7
378	1 0 0 0 0 0 0 0 0 0 0 3 7
379	1 0 0 0 0 0 0 0 0 0 0 3 7
380	1 0 0 0 0 0 0 0 0 0 0 3 7

<u>Catalogue Number</u>	<u>Typological Code</u>
	A B C D E F G H I J K L M
381	1 0 0 0 0 0 0 0 0 0 0 0 3 7
382	1 0 0 0 0 0 0 0 0 0 0 0 3 7
383	1 0 0 0 5 3 0 0 0 0 0 0 3 7
384	1 0 0 0 0 0 0 0 0 0 0 0 3 7
385	1 0 0 0 0 0 0 0 0 0 0 0 3 7
386	1 0 0 0 0 0 0 0 0 0 0 0 3 7
387	7 0 8 7 0 0 1 1 1 1 1 3 7
388	7 0 8 7 0 0 1 1 1 1 1 3 7
389	7 0 8 7 0 0 1 1 1 1 1 3 7
390	4 0 7 5 0 0 1 1 1 1 1 2 1
391	1 0 0 0 0 0 0 0 0 0 0 0 2 2
392	1 0 1 6 1 3 1 4 5 4 2 2 2
393	2 5 1 2 5 2 1 2 4 3 2 2 2
394	2 0 1 2 5 2 1 2 4 3 2 2 2
395	2 0 1 6 5 3 1 2 4 3 2 2 2
396	3 1 1 1 2 2 1 1 1 1 1 2 1
397	1 0 0 0 0 0 0 2 0 3 2 2 2
398	1 0 0 0 0 0 0 4 4 2 2 1 2
399	1 0 0 0 0 0 0 4 0 2 2 1 2
400	3 3 3 1 4 3 1 2 5 3 2 2 3

<u>Catalogue Number</u>	<u>Typological Code</u>
	A B C D E F G H I J K L M
401	1 0 1 0 1 3 1 4 2 4 2 2 2
402	1 0 0 0 0 0 0 4 0 2 2 2 2
403	2 6 1 6 0 0 1 4 2 3 2 2 1
404	2 6 1 6 1 3 1 4 2 4 2 2 2
405	1 0 0 0 0 0 0 4 0 4 2 2 2
406	2 4 1 2 5 2 1 2 4 3 2 2 2
407	1 0 0 0 0 0 0 0 0 0 0 1 4
408	3 1 6 6 1 2 1 1 1 1 1 2 2
409	2 0 1 2 5 3 1 2 4 3 2 2 2
410	1 0 0 0 0 0 0 4 0 2 6 2 2
411	2 0 1 6 1 3 1 4 2 3 2 4 1
412	1 0 3 3 5 2 1 2 6 3 3 1 1
413	2 4 1 2 5 3 1 2 4 3 2 2 2
414	2 4 1 3 5 2 1 2 2 3 2 2 1
415	1 0 0 0 0 0 6 0 0 0 0 1 1
416	2 3 7 6 1 3 1 4 2 4 2 2 1
417	1 0 0 0 0 0 0 4 0 2 2 2 1
418	2 3 1 2 1 3 7 2 5 3 2 2 1
419	1 0 0 0 0 0 0 0 0 0 6 2 1
420	1 0 2 6 0 0 0 0 0 0 0 2 4

<u>Catalogue Number</u>	<u>Typological Code</u>
	A B C D E F G H I J K L M
421	1 0 0 0 0 0 0 0 0 0 6 1 2
422	1 0 1 2 0 0 0 2 4 3 2 1 2
423	2 0 1 2 5 3 1 2 4 3 2 2 2
424	2 0 1 2 5 3 1 2 4 3 2 2 2
425	2 3 1 2 1 3 1 4 5 2 2 2 2
426	1 0 0 0 0 0 2 9 0 5 5 4 1
427	1 0 0 0 0 0 0 4 0 2 2 1 1
428	1 0 0 0 0 0 0 4 0 2 2 1 2
429	2 0 4 4 1 2 4 2 4 3 2 1 2
430	1 0 0 0 0 0 0 0 0 0 0 1 2
431	1 0 0 6 0 0 0 4 0 2 2 1 1
432	3 3 5 1 4 3 1 6 3 3 2 2 1
433	3 3 5 1 4 3 1 6 3 3 2 2 1
434	1 0 0 0 0 0 0 4 0 2 2 4 2
435	2 3 5 6 1 3 1 4 2 4 2 2 2
436	1 0 0 6 0 0 0 4 0 2 2 2 1
437	2 0 1 6 1 3 0 4 2 4 2 2 2
438	2 0 1 6 0 0 0 4 2 4 2 1 1
439	5 0 0 0 2 2 0 0 0 0 0 1 4
440	1 0 0 0 0 0 0 2 5 3 2 4 3

<u>Catalogue Number</u>	<u>Typological Code</u>
	A B C D E F G H I J K L M
441	2 4 1 2 5 2 1 2 4 3 2 2 2
442	2 4 1 1 1 3 5 4 6 4 6 2 2
443	1 0 0 3 2 3 0 2 2 3 3 1 1
444	1 0 0 0 0 0 0 4 0 2 2 1 2
445	1 0 0 5 4 3 0 0 0 0 0 2 1
446	2 0 7 6 1 2 1 4 2 4 2 2 1
447	1 0 0 0 0 0 0 0 0 0 6 1 2
448	4 2 6 1 1 2 1 1 1 1 1 2 1
449	2 0 1 6 1 3 1 4 2 4 2 2 2
450	1 0 0 0 0 0 0 4 0 2 2 2 1
451	2 5 1 2 5 3 1 2 4 3 2 2 2
452	1 0 0 0 0 0 0 0 0 0 0 2 2
453	1 0 0 0 0 0 0 0 0 0 0 1 3
454	2 6 1 6 1 3 1 4 4 4 2 2 1
455	1 0 1 6 0 0 0 4 0 2 2 1 2
456	2 4 1 6 1 3 1 4 6 4 2 2 1
457	2 3 1 6 1 3 1 4 2 2 2 2 2
458	1 0 0 0 0 0 3 0 0 0 0 3 3
459	1 0 0 0 0 0 0 0 0 0 0 1 2
460	1 0 1 0 0 0 0 2 4 3 2 4 2

<u>Catalogue Number</u>	<u>Typological Code</u>
	A B C D E F G H I J K L M
461	1 0 0 0 0 0 0 0 0 0 0 1 4
462	1 0 0 0 0 0 0 0 0 0 0 1 2
463	1 0 0 0 0 0 0 2 2 3 2 1 2
464	1 0 0 0 5 3 0 0 0 0 0 1 2
465	7 0 8 7 0 0 0 1 1 1 1 1 2
466	1 0 0 0 0 0 0 0 0 0 0 1 3
467	1 0 0 0 0 0 0 2 3 3 2 1 3
468	1 0 0 0 0 0 0 2 4 3 2 1 3
469	1 0 2 0 0 0 0 0 0 0 0 1 4
470	1 0 0 0 0 0 0 0 0 0 0 1 1
471	1 0 0 0 0 0 0 0 0 0 0 1 1
472	1 0 0 0 0 0 0 0 0 0 0 1 1
473	1 0 0 0 0 0 0 0 0 0 0 1 3
474	2 6 1 0 0 0 1 2 6 3 3 2 1
475	2 0 0 0 0 0 1 1 1 1 1 4 0
476	1 0 0 0 0 0 0 0 0 0 0 1 3
477	2 0 2 0 0 0 0 0 0 0 0 1 4
478	2 0 2 0 5 3 0 0 0 0 0 1 4
479	1 0 0 0 0 0 0 0 0 0 0 1 4
480	1 0 0 0 0 0 0 0 0 0 0 1 4

<u>Catalogue Number</u>	<u>Typological Code</u>
	A B C D E F G H I J K L M
481	1 0 0 2 0 0 0 0 0 0 0 1 4
482	1 0 2 0 0 0 0 0 0 0 0 1 4
483	1 0 2 0 0 0 0 0 0 0 0 1 4
484	1 0 0 0 0 0 0 0 0 0 0 1 4
485	2 0 2 0 0 0 0 0 0 0 0 1 4
486	2 0 2 0 5 3 0 0 0 0 5 1 4
487	1 0 0 0 5 3 0 4 2 3 2 1 4
488	2 0 2 0 0 0 0 0 0 0 0 1 4
489	1 0 0 0 0 0 0 7 0 0 3 1 4
490	1 0 0 0 0 0 0 0 0 0 0 1 4
491	7 0 8 7 0 0 0 1 1 1 1 1 4
492	1 0 0 1 0 0 0 0 0 0 0 1 4
493	1 0 0 0 0 0 0 0 0 0 0 1 4
494	1 0 0 0 0 0 0 3 0 3 3 1 4
495	1 0 0 0 0 0 0 0 0 0 0 1 4
496	1 0 0 0 0 0 0 0 0 0 0 1 4
497	1 0 0 0 0 0 0 0 0 0 0 1 4
498	2 0 2 0 4 3 0 0 0 0 0 1 4
499	2 0 2 0 5 3 0 0 0 0 0 1 4
500	1 0 0 0 0 0 0 0 0 0 0 1 4

<u>Catalogue Number</u>	<u>Typological Code</u>
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505	6 4 3 1 4 3 1 6 5 2 2 2 4
506	4 2 7 1 4 3 1 4 5 5 2 2 4
507	2 4 2 6 5 3 1 2 5 3 2 2 4
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510	7 0 8 7 0 0 1 1 1 1 1 2 4
511	2 3 2 6 5 3 1 2 5 3 2 2 4
512	2 4 2 6 5 3 1 1 1 1 1 2 4
513	1 0 2 0 0 0 0 0 0 0 0 2 4
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525	2 0 2 6 5 3 1 1 1 1 5 2 4
526	2 0 2 6 0 0 1 9 3 6 2 2 4
527	1 0 0 0 0 0 0 0 0 0 0 2 4
528	1 0 0 0 0 0 0 0 0 0 0 2 4
529	1 0 0 0 0 0 0 0 0 0 0 2 4
530	1 0 0 0 0 0 0 0 0 0 0 1 4
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532	1 0 0 0 0 0 0 0 0 0 0 1 4
533	1 0 0 0 0 0 0 0 0 0 0 3 4
534	2 0 2 6 0 0 0 0 0 0 0 3 4
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536	2 0 2 6 0 0 0 0 0 0 0 3 4
537	2 0 2 0 5 3 0 0 0 0 0 3 4
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554	2 0 0 0 0 0 3 0 0 0 0 3 9
555	2 0 0 0 0 0 3 0 0 0 0 3 9
556	2 0 0 0 5 2 3 2 2 3 2 3 9
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569	1 0 0 0 0 0 0 2 5 3 2 3 9
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573	2 0 2 6 5 3 0 0 0 0 0 3 9
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587	1 0 0 6 0 0 0 0 0 0 0 3 9
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594	1 0 0 0 5 1 0 0 0 0 0 3 9
595	1 0 0 0 0 0 0 4 0 4 2 3 9
596	1 0 0 0 0 0 8 7 5 3 3 3 9
597	1 0 0 0 5 2 0 0 0 0 0 3 9
598	1 0 0 0 0 0 0 2 0 3 2 3 9
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609	1 0 0 0 0 0 0 4 0 2 2 3 9
610	1 0 0 0 0 0 0 2 2 3 2 3 9
611	2 0 0 0 0 0 3 0 0 0 0 3 9
612	2 0 0 0 0 0 3 2 2 3 2 3 9
613	1 0 0 0 5 2 8 7 0 2 3 3 9
614	1 0 0 1 0 0 0 2 2 3 2 3 9
615	1 0 0 0 0 0 0 3 0 3 3 3 9
616	4 3 6 6 1 2 1 1 1 1 1 2 1
617	2 6 1 2 3 2 3 2 2 3 2 2 3
618	3 5 6 6 3 2 1 3 4 3 3 2 3
619	2 5 1 2 5 2 3 2 2 3 2 2 3
620	2 5 1 2 4 3 3 2 2 3 2 2 3

<u>Catalogue Number</u>	<u>Typological Code</u>
	A B C D E F G H I J K L M
621	2 5 1 2 4 3 3 2 2 3 2 2 3
622	1 0 0 0 0 0 0 4 0 2 2 1 2
623	1 0 0 0 0 0 0 4 0 2 6 1 2
624	1 0 0 0 0 0 0 0 0 0 0 2 2
625	1 0 0 0 0 0 0 4 0 2 2 1 1
626	1 0 0 0 0 0 0 2 0 3 2 3 2
627	1 0 0 0 0 0 0 2 0 3 2 3 2
628	1 0 0 0 0 0 0 2 0 3 2 3 2
629	1 0 0 2 0 0 0 2 0 3 2 3 2
630	1 0 0 0 0 0 0 2 4 3 2 3 2
631	1 0 0 0 0 0 0 2 0 3 2 3 2
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633	1 0 0 0 0 0 0 0 0 0 0 3 2
634	1 0 0 0 0 0 0 2 0 3 2 3 2
635	1 0 0 0 0 0 0 0 0 0 0 3 2
636	4 2 6 3 4 2 1 2 2 3 2 2 2
637	1 0 0 0 0 0 0 0 0 0 0 1 4
638	1 0 0 0 0 0 0 0 0 0 0 1 4
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640	2 0 4 4 4 2 1 2 4 3 3 2 1

<u>Catalogue Number</u>	<u>Typological Code</u>
	A B C D E F G H I J K L M
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642	1 0 0 0 0 0 0 0 0 0 0 1 3
643	1 0 1 0 4 3 0 2 2 3 2 1 3
644	1 0 0 0 0 0 0 0 0 0 0 1 3
645	1 0 3 0 3 2 0 5 2 3 5 1 4
646	1 0 0 0 3 2 0 2 0 3 2 1 3
647	1 0 5 1 5 3 0 2 4 3 2 1 3
648	1 0 0 0 0 0 0 0 0 0 0 1 3
649	6 3 3 1 5 3 1 9 3 3 2 1 3
650	1 0 0 0 0 0 3 2 2 3 2 1 3
651	1 0 0 0 0 0 0 0 0 0 0 1 0
652	1 0 0 0 0 0 0 2 0 3 2 1 3
653	1 0 0 0 0 0 0 2 0 3 2 1 3
654	1 0 0 0 0 0 0 0 0 0 0 1 3
655	4 2 6 6 1 2 1 4 4 2 2 2 1
656	1 0 0 0 0 0 0 4 0 2 2 1 1
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660	1 0 0 0 0 0 0 0 0 0 0 1 2

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665	1 0 0 0 0 0 0 0 0 0 0 1 4
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671	1 0 0 0 0 0 0 0 0 0 0 1 3
672	1 0 0 0 0 0 0 0 0 0 0 1 0
673	1 0 0 0 0 0 0 0 0 0 0 1 0
674	1 0 0 0 0 0 3 0 0 0 0 4 0
675	1 0 0 0 0 0 0 4 0 2 2 1 2
676	4 0 6 1 0 0 1 2 4 3 2 1 2
677	1 0 0 0 0 0 0 2 3 3 2 1 2
678	1 0 0 0 0 0 0 2 0 3 2 1 2
679	1 0 0 0 5 3 0 2 2 3 2 1 2
680	1 0 0 0 0 0 0 2 0 3 2 1 3

<u>Catalogue Number</u>	<u>Typological Code</u>
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682	2 3 1 6 1 3 1 4 2 4 2 4 2
683	1 0 0 0 0 0 0 0 0 0 0 1 0
684	1 0 0 0 0 0 0 2 0 3 2 1 2
685	1 0 0 0 0 0 0 0 0 0 6 1 2
686	1 0 0 0 0 0 0 0 0 0 6 1 2
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689	1 0 0 0 0 0 0 0 0 0 0 1 2
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691	1 0 0 0 0 0 0 3 0 3 3 1 3
692	1 0 0 0 0 0 0 0 0 0 0 1 3
693	2 3 2 6 5 3 1 1 1 1 5 2 4
694	2 0 1 2 4 2 3 2 2 3 2 1 3
695	2 0 7 6 1 3 1 4 4 4 2 4 1
696	2 4 1 2 5 2 1 2 4 3 2 4 2
697	1 0 0 0 1 3 8 2 2 3 2 1 4
698	2 4 1 6 4 3 1 4 2 4 2 2 1
699	2 4 1 6 4 3 1 4 2 4 2 2 1
700	2 4 1 2 5 2 1 2 3 3 2 2 2

<u>Catalogue Number</u>	<u>Typological Code</u>
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702	2 3 1 2 1 2 1 4 2 4 2 1 1
703	1 0 0 0 0 0 0 4 0 2 2 1 1
704	1 0 0 0 0 0 0 4 0 2 2 1 2
705	1 0 0 0 0 0 0 4 0 2 2 1 2
706	1 0 0 0 0 0 0 0 0 0 0 1 2
707	1 0 0 0 0 0 0 0 0 0 0 1 2
708	1 0 0 0 0 0 0 0 0 0 0 1 2
709	1 0 0 0 0 0 0 0 0 0 0 1 4
710	4 2 5 1 5 2 1 1 1 1 1 1 0
711	5 0 0 0 4 3 0 4 2 3 2 1 0
712	4 2 7 5 5 3 1 4 2 3 2 2 1
713	1 0 0 0 0 0 0 2 0 3 3 1 3
714	1 0 0 0 0 0 0 0 0 0 0 1 3
715	1 0 0 0 5 3 0 2 0 3 2 1 4
716	1 0 0 0 0 0 3 2 0 3 2 1 3
717	1 0 0 0 0 0 0 2 0 3 2 1 3
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723	2 4 1 6 1 3 1 4 6 4 2 1 1
724	1 0 0 0 0 0 0 2 0 3 3 1 1
725	1 0 0 0 0 0 0 0 0 0 0 0 1 1
726	1 0 0 0 0 0 0 0 0 0 0 0 1 1
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734	1 0 0 0 0 0 0 4 0 2 2 1 1
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736	1 0 0 0 0 0 0 0 0 0 0 0 1 4
737	1 0 0 0 4 3 0 2 2 3 2 3 7
738	1 0 0 0 0 0 0 2 2 3 3 3 7
739	1 0 0 0 4 2 0 0 0 0 0 3 7
740	1 0 0 0 0 0 0 2 0 3 3 3 7

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744	2 6 1 2 4 3 3 2 2 4 2 2 3
745	4 2 1 6 5 2 1 2 2 3 2 2 3
746	4 0 1 6 5 2 1 1 1 1 1 2 3
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748	2 0 1 0 0 0 3 2 2 3 2 2 3
749	1 0 0 0 0 0 0 4 0 2 6 1 2
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751	1 0 0 0 0 0 0 2 0 3 2 1 3
752	1 0 0 0 0 0 0 0 0 0 0 1 4
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754	1 0 0 0 0 0 0 2 0 3 2 3 3
755	1 0 0 0 4 2 0 2 3 3 2 2 2
756	1 0 0 0 0 0 0 2 0 3 2 1 4
757	1 0 0 0 0 0 0 0 0 0 0 1 0
758	1 0 0 0 0 0 0 2 3 3 2 1 0
759	1 0 0 0 0 0 0 0 0 0 0 1 4
760	1 0 0 0 5 3 0 0 0 0 0 1 0

<u>Catalogue Number</u>	<u>Typological Code</u>
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763	1 0 0 0 0 0 0 0 0 0 0 1 0
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766	1 0 0 0 0 0 0 2 0 3 2 4 3
767	2 4 1 6 1 3 1 4 2 4 2 1 1
768	1 0 0 0 0 0 3 0 0 0 0 4 0
769	3 0 5 1 4 3 1 6 3 3 2 2 1
770	3 0 5 1 4 3 1 6 3 3 2 2 1
771	1 0 0 0 0 0 3 0 0 0 0 3 6
772	1 0 0 0 5 3 0 2 4 3 2 3 2
773	3 0 5 1 0 0 2 2 5 2 3 3 2
774	1 0 0 0 0 0 0 2 2 3 2 3 2
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776	1 0 0 0 5 2 0 2 2 3 2 3 2
777	1 0 0 0 0 0 0 4 0 2 2 3 2
778	1 0 0 0 0 0 0 4 0 2 2 3 2
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785	1 0 0 0 0 0 0 0 0 0 0 3 2
786	1 0 0 0 0 0 0 2 0 3 2 3 2
787	1 0 0 0 0 0 0 6 0 5 5 4 1
788	1 0 0 0 0 0 0 6 0 5 5 4 1
789	2 0 7 1 5 2 1 1 1 1 1 4 1
790	1 0 0 0 0 0 0 2 2 3 2 1 2
791	1 0 0 0 0 0 0 6 0 0 2 3 1
792	2 0 0 0 1 3 0 4 0 2 2 1 1
793	1 0 0 0 0 0 0 0 0 0 0 1 2
794	1 0 0 0 0 0 0 0 0 0 0 1 3
795	1 0 0 0 0 0 2 2 0 2 3 3 2
796	4 2 5 3 5 2 1 2 6 3 2 2 1
797	1 0 0 0 0 0 0 0 0 0 0 1 0
798	1 0 0 0 0 0 0 0 0 0 0 4 0
799	1 0 0 0 0 0 8 7 5 6 3 1 2
800	1 0 0 0 0 0 0 2 0 3 2 1 2

<u>Catalogue Number</u>	<u>Typological Code</u>
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802	1 0 0 0 0 0 0 4 0 2 2 3 2
803	1 0 0 0 0 0 0 2 0 3 3 4 0
804	1 0 0 0 0 0 0 0 0 0 0 1 0

The next stage in the typological description concerns problems arising from typological development. It is one task to establish a series of typologically related vessels but quite another to determine precisely the factors of continuity involved. Traditionally, decorative elements are used to define any continuity mainly for the reason that these elements are clearly apparent. Elements of form are less often used on the misunderstanding that typological continuity occurs only within the decorative elements on a given basic form. If one considers the main typological elements, namely those of form, proportion, decoration, technique and material, it can be seen that continuity can exist in any one, and in isolation from the other four. Thus in establishing a series of continuity, any of these five elements can be treated separately and subsequently related to the other series. When these series have been established they can be combined to produce a total picture.

Continuity can only be established by means of typological similarity. Initially each individual element listed above has to be compared to the same element in every other vessel. When this is carried

out it is possible to define each element in terms of a progression. When all typological elements are then placed together to produce a full list for each vessel it becomes possible to plot the loss, change or addition of individual elements. Assuming that a progression of continuity has been established in this way the problem now lies in establishing the direction in which the progression is moving. Any loss, change or addition of attributes represents a sequence from a given vessel. Whether this sequence indicates a continuity leading to or leading from that vessel is another matter. To establish a correct relative chronology, that is to say the correct sequence of progression typologically, then either as many vessels as possible should be closely dated, or more practically, associated artefacts in closed finds should provide a basis for the correct direction of development.

Although all these typological elements can be measured objectively, slight variation within a particular element can only be measured subjectively. The more visually insignificant the variation, the harder it becomes to define it objectively. The larger the variation, the greater the degrees of amplitude from the initial standard and hence the greater the potential for finding points on which to base objective measurements.

Any system of continuity assumes one basic fact, namely that two physically similar vessels lie close in time to each other. This assumption has to be made to produce a workable and practical method of typological analysis.

CHAPTER FIVE - REFERENCES AND NOTES

- (1) Brew J.O. 'The Use and Abuse of Taxonomy' Papers of the Peabody Museum, 21, 1864, p. 46.
- (2) The computer programme for this material (Programme SORT) was written by Mr. J. Crummit of Bradford University. It was initially hoped to use cluster analysis on the data but the quantity of unknown information per item (signified by digit 0 in the typological lists) made this impossible. The programme used provided a simple and satisfactory method of accelerating a very tedious and laborious manual task.

CHAPTER SIX - TYPOLOGICAL ANALYSIS

Now that the various typological characteristics have been evaluated for each item it becomes possible to plot the individual elements on a chronological scale. In the typological lists the final column relates to general Scandinavian chronological periods and is used to provide basic grouping factors for the material. In an effort to overcome the rigidity of this system and in order to provide a more precise dating coverage the individual dates from each archaeological context are used. These are found at the end of each catalogue entry. In theory it is possible to isolate individual elements and to plot them chronologically either on their own or in combination with other elements. A further variable can be added, namely the archaeological context of the glasses which is represented by the penultimate column. This ensures that distribution and frequency can be discussed in full awareness of the find context.

The method chosen for plotting the glasses chronologically was as follows. All relevant items containing the same characteristic element under discussion (i.e. presence of coloured trails) were listed together with the specific catalogue date for each item. A histogram was produced in which each vertical column represented a period of 50 years from AD 25 - 1025 (20 columns). The first column therefore contained the quantity of items in that list whose dating span included the year AD 50, the second column those which included the year AD 100, the third the year AD 150 and so on until the list of items was exhausted. The resulting histograms show firstly the total chronological

range of the typological element in question and secondly, assuming that there are sufficient items, the approximate chronological peak of the frequency of that particular element. By a process of combination it was possible to study the find frequency of particular items or of particular typological elements in relation to both geographical distribution and to find situation.

The method was the result of much experimentation into the best possible use of the chronological information available. It was stated earlier (Chapter 4) that the primary criterion for investigation should be selected for the reason that it would embrace more of the items at the initial stage than any other method. For this reason chronology was selected as being the most fitting. It is by no means perfect but providing it is used consistently it should provide for a more accurate analysis than those traditionally produced. It has the advantage of being able to accommodate the smallest and most mutilated fragment.

The disadvantages, however, are several and should be pointed out. The method can only include those finds which lie in a datable context. It excludes items which are not dated or whose dating has only been formulated by association with other glass items. It takes into account 'heirloom' or very old objects only to the extent that they appear in the histograms as anomalies to the main chronological ranges of their type. The dating ranges which are produced only concern a relative chronology of deposition by way of burial or breakage. They do not necessarily relate to the date of manufacture.

The main disadvantage is that the method requires that each item

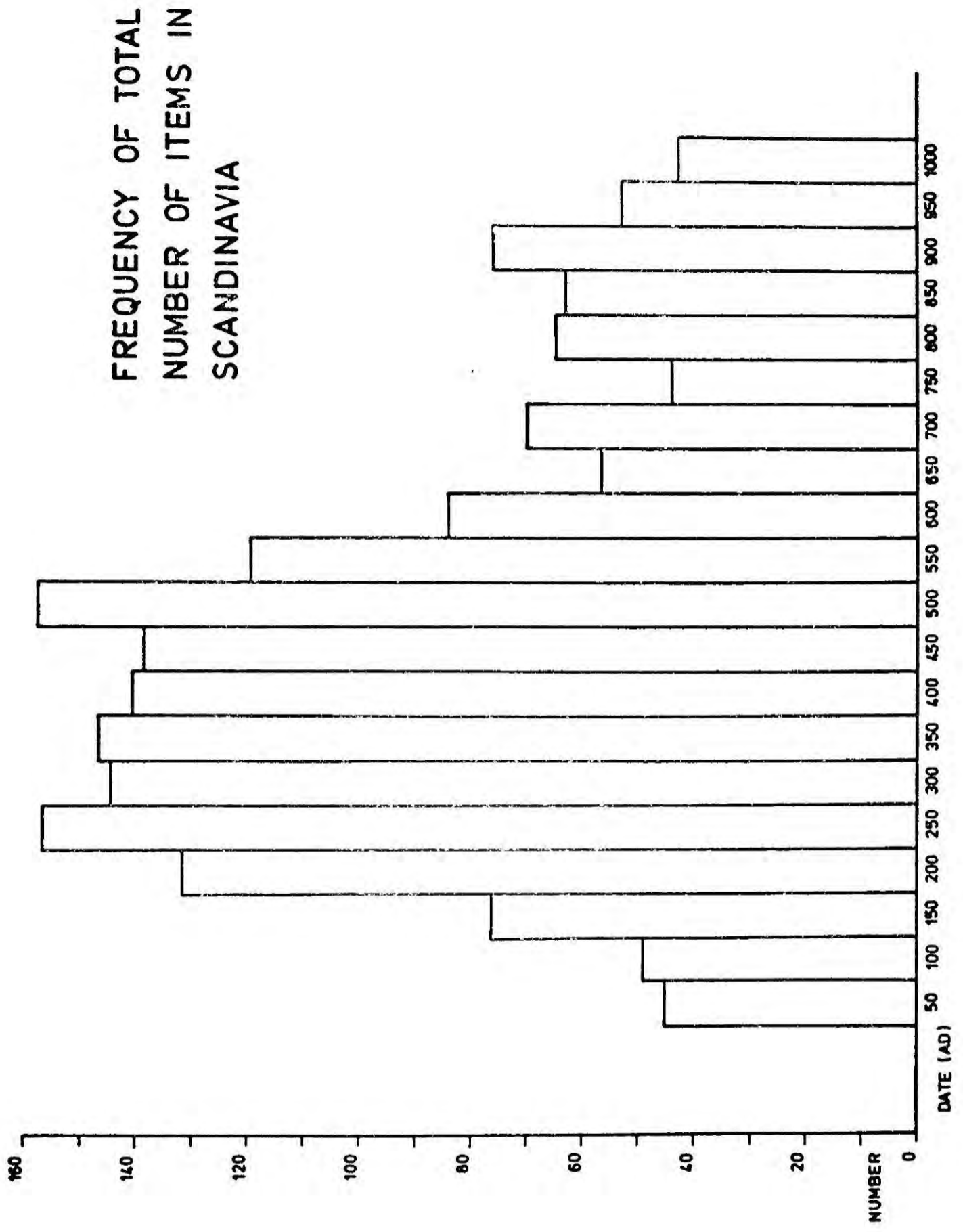
has a suitable dating context. The more precise the dating, the clearer the overall picture. Although several items are included which have individual dating ranges of over 300 years (notably from the early part of the millennium), it was necessary to exclude most items which had individual ranges greater than this. It was impossible to include the Helgo material for this reason. A dating range approaching 500 years was involved.

All the histograms contain a correction factor. In several instances the find context is dated to a particular period in Scandinavian chronology i.e. AD 200 - 400 (later Roman Iron Age) or AD 400 - 550/600 (Migration Period). These tend to occur in the earlier published reports where a general date to a particular period was quite satisfactory and acceptable. It became necessary to cancel out adjacent pairs of these dates which occurred at the hypothetical times when these periods changed. Consequently if four items were dated to between AD 200 - 400 and another four to between AD 400 - 550/600, four values rather than eight would be counted in the histogram column for AD 375 - 425. If this was not carried out a false frequency would have been produced at AD 400, 550/600 and 800 which are the changing points for the traditional Scandinavian chronology.

Total Frequency of Scandinavian Glass

The first histogram (fig 5) illustrates the chronological range of all the available dated material from the corpus. In terms of the frequency of the finds the period between AD 200 - 550 seems to have been the most prolific. A lower but nevertheless noticeable peak appears

FIG 5.



between AD 800 - 900. One can make few conclusions about these phenomena. The frequency as shown here could reflect either burial custom or even the non-random occurrence of the finds themselves. Gravefields such as those as Møllegårdsmarken (Denmark) and Birka (Sweden) where large quantities of material appear could easily be responsible for the shape of the graph. The significance of the graph however lies in its value as a backcloth. The relative frequency of particular vessel types, vessels from various countries or the number of items from a particular burial practice can always be set against this backcloth for comparative purposes. This ensures that the frequency of a particular series is related to the frequency of the material as a whole.

The second step is to plot the complete and fragmentary items against this backcloth. This can be seen in figs 6 and 7 respectively. The large quantity of fragmentary items illustrated here would normally have been omitted under a conventional methodology. The graph of fragments shows a discrepancy between the frequency of fragmentary items and the frequency of the total items between ca. AD 200 - 500 and this is a situation which may be explained later by consideration of the burial custom. The frequency of complete items coincides remarkably well with the overall picture of the total items. In theory the sum of the complete and fragmentary vessels per column should correspond with the total backcloth figure for that column. These are however a few instances where an item included in the total column does not appear in either the complete or fragmentary lists due to insufficient information.

FIG 6.

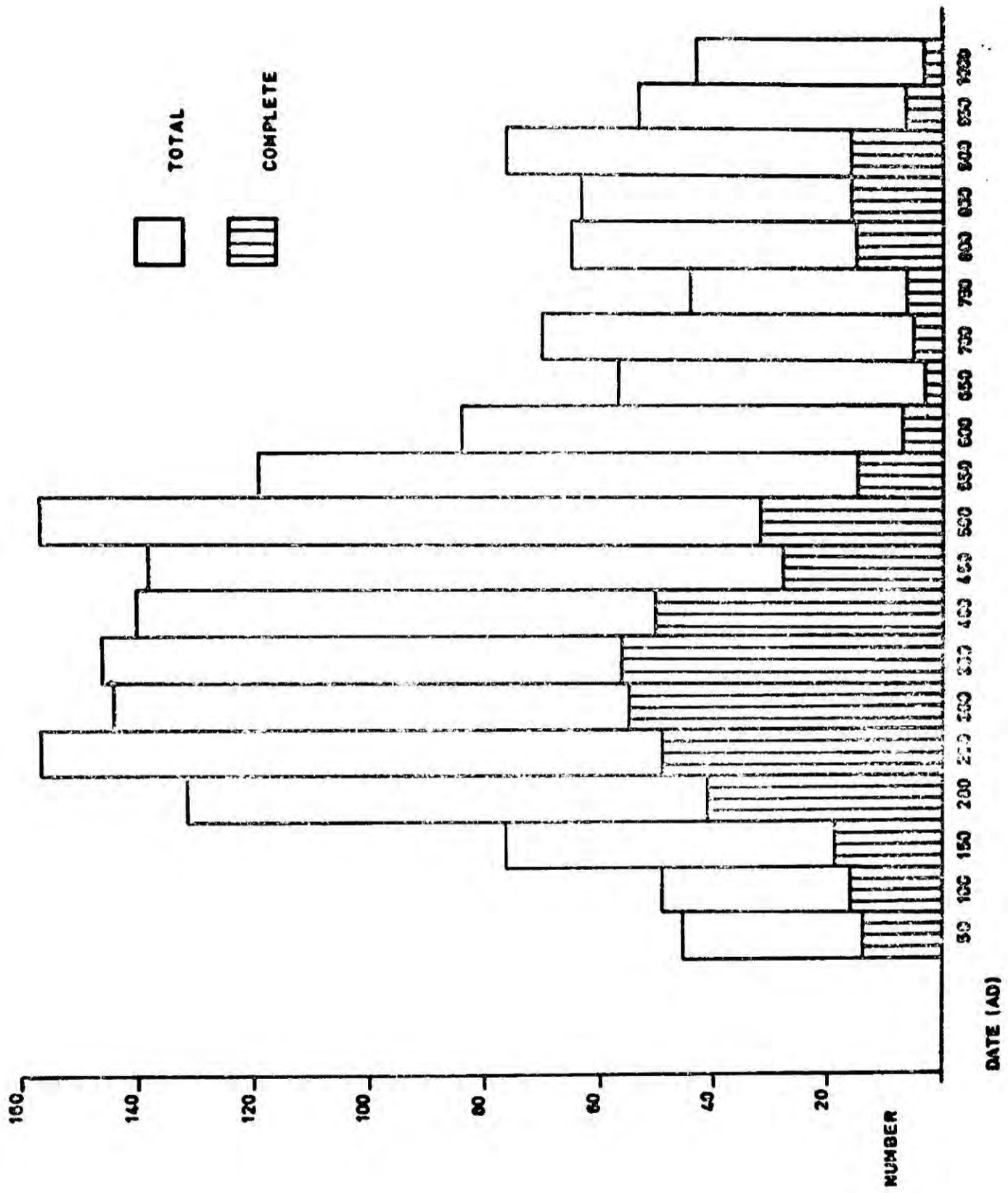
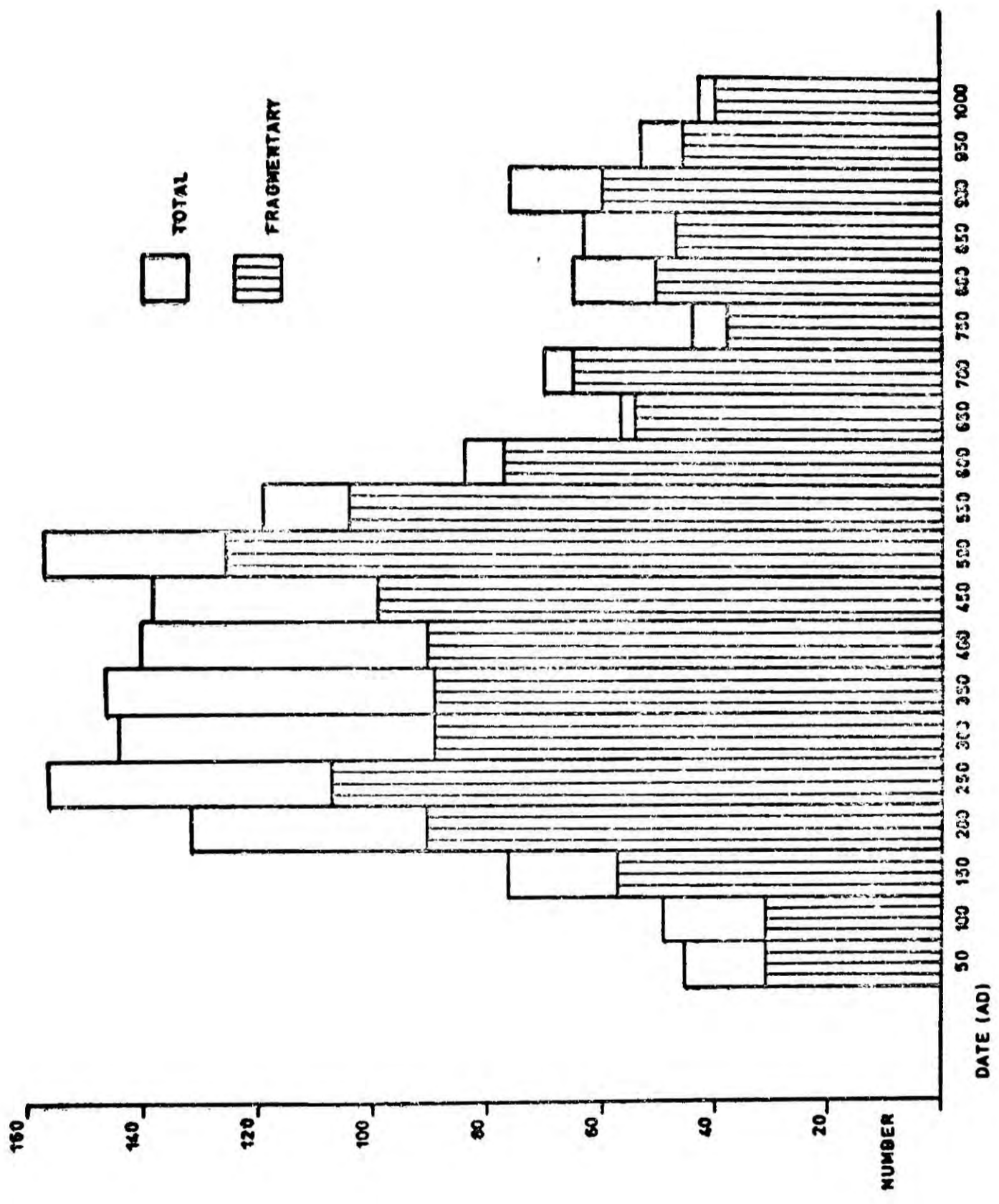


FIG 7.



The number of such items is small and their exclusion makes no significant difference to the overall picture. The main point emphasised by the graph is that complete glasses represent only a small part of the evidence.

Geographical Frequency

The system used here also facilitates the study of the geographical distribution of the glasses. For example fig 8 shows the chronological distribution and frequency of all the items in Bornholm in comparison to the same for all of Scandinavia. Fig 9 does the same for Denmark, fig 10 for Gotland, fig 11 for Norway, fig 12 for Sweden and fig 13 for Öland. Figs 14 and 15 show the division of Sweden into two distinct geographical areas containing the finds from the 'wealthy' Uppland and Södermanland regions and the finds from the rest of Sweden respectively. It becomes increasingly more apparent throughout this exercise that there is a dichotomy between the two areas and this will be discussed in detail as it arises. In the following tables Sweden is divided into eastern and western areas. The former essentially contains finds from the Uppland and Södermanland regions and the latter from the rest of the country.

This geographical distribution throughout Scandinavia contains some interesting features. If one examines the major frequency peaks in the various countries and islands there is a very noticeable movement. This starts in Bornholm and Denmark where the frequency is at its approximate height between AD 50 - 400. The emphasis shifts slightly to Norway and W. Sweden between AD 200 - 500. The next peak is in

FIG 8.

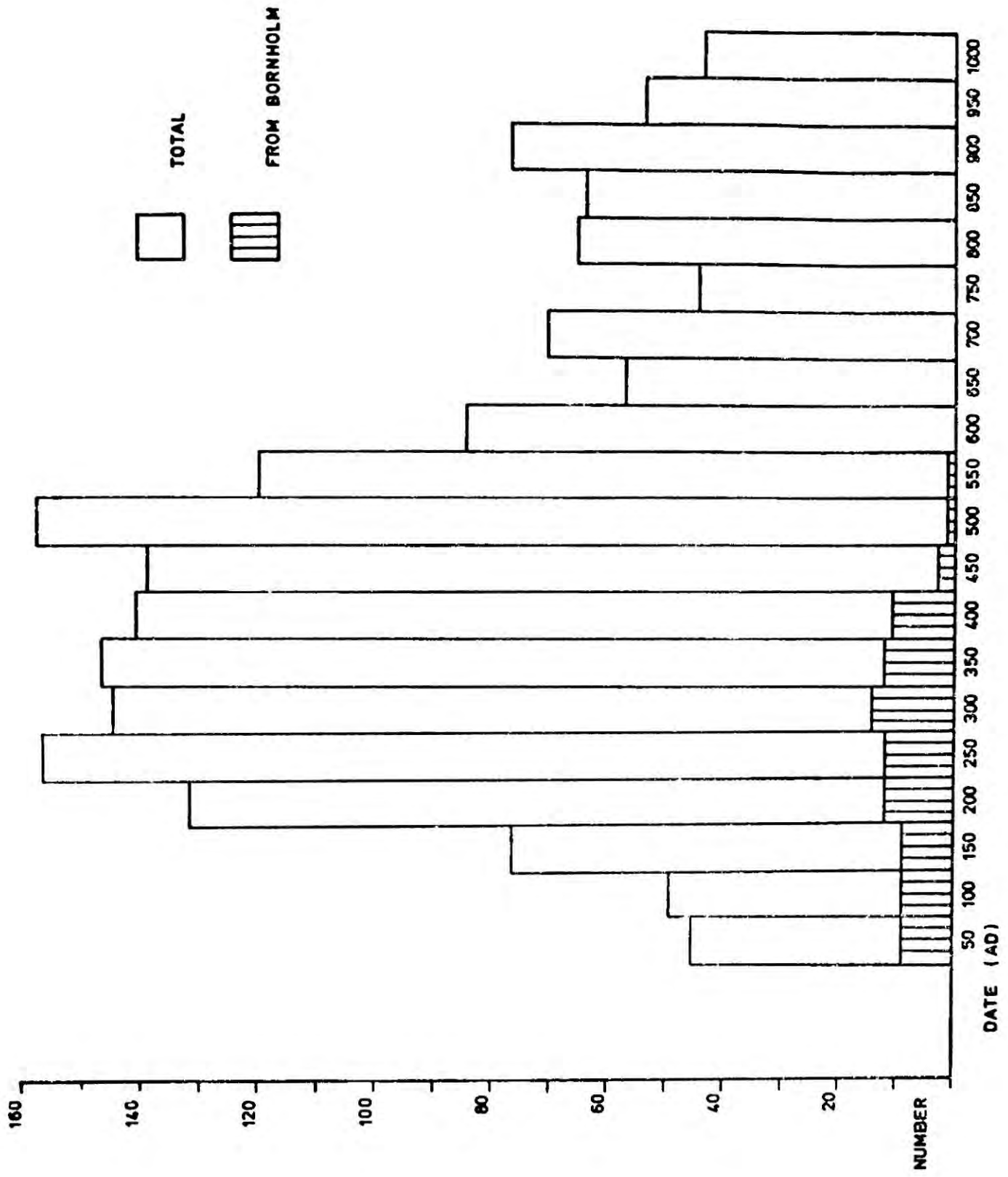


FIG 9.

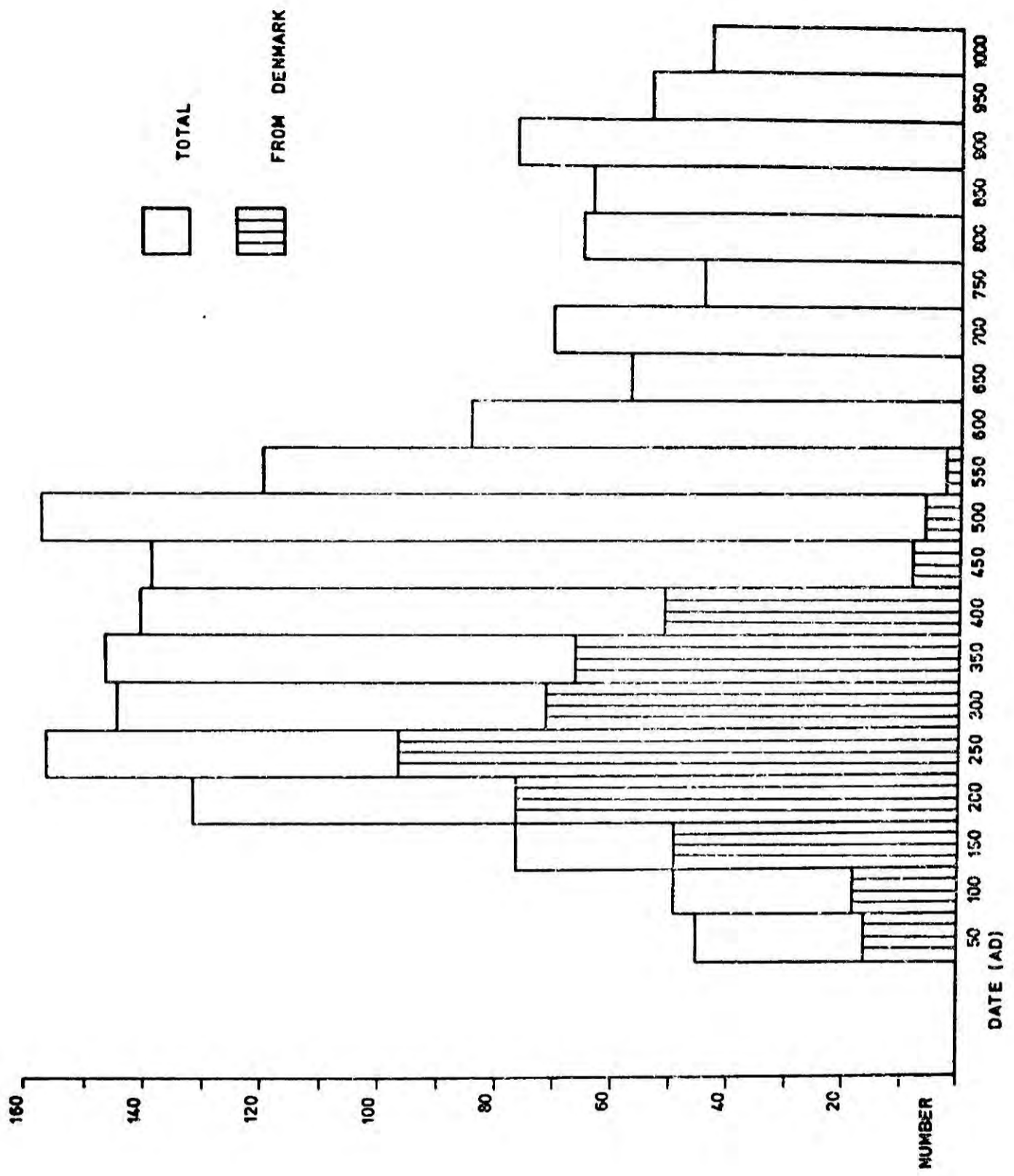


FIG 10.

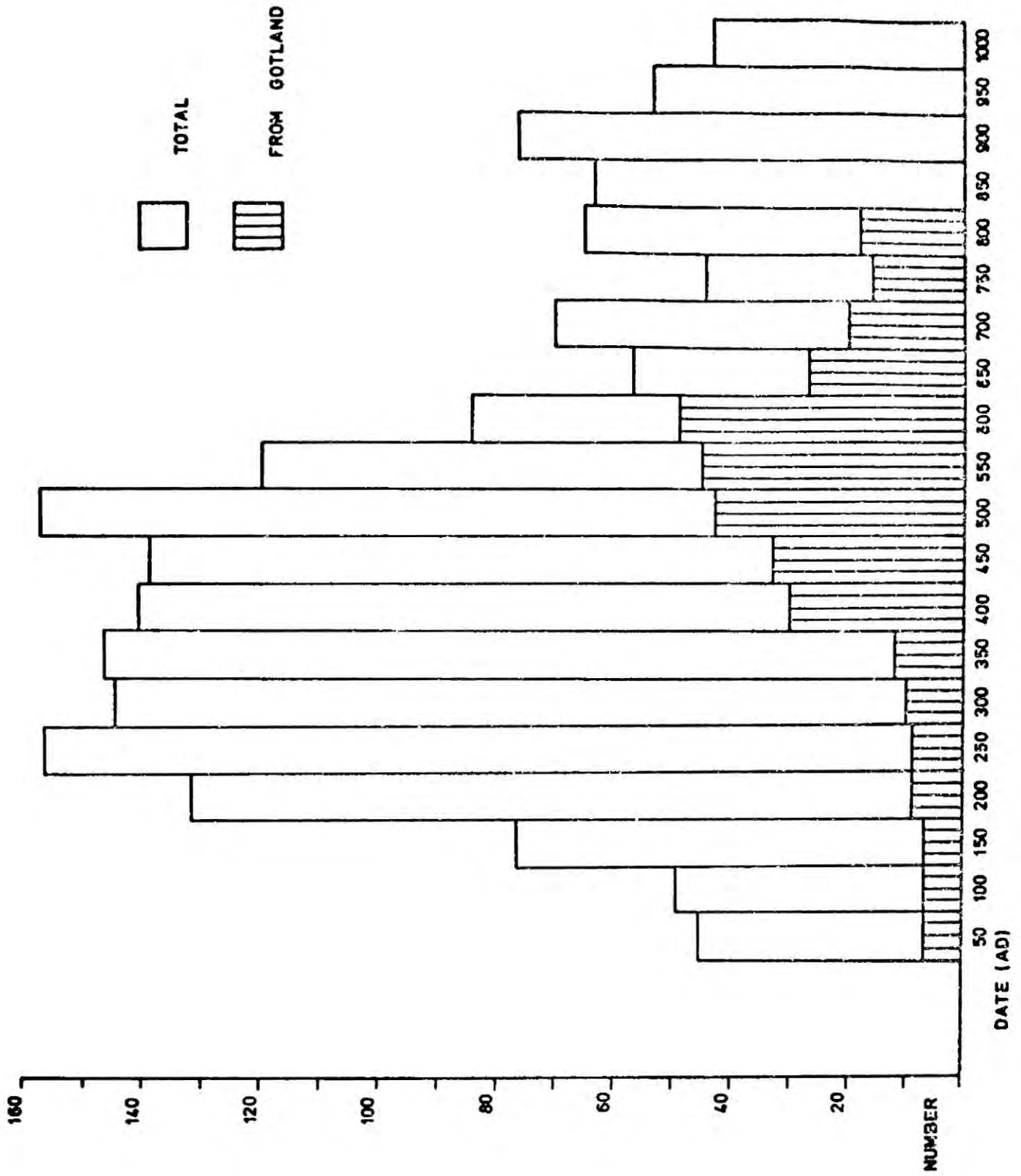


FIG 11.

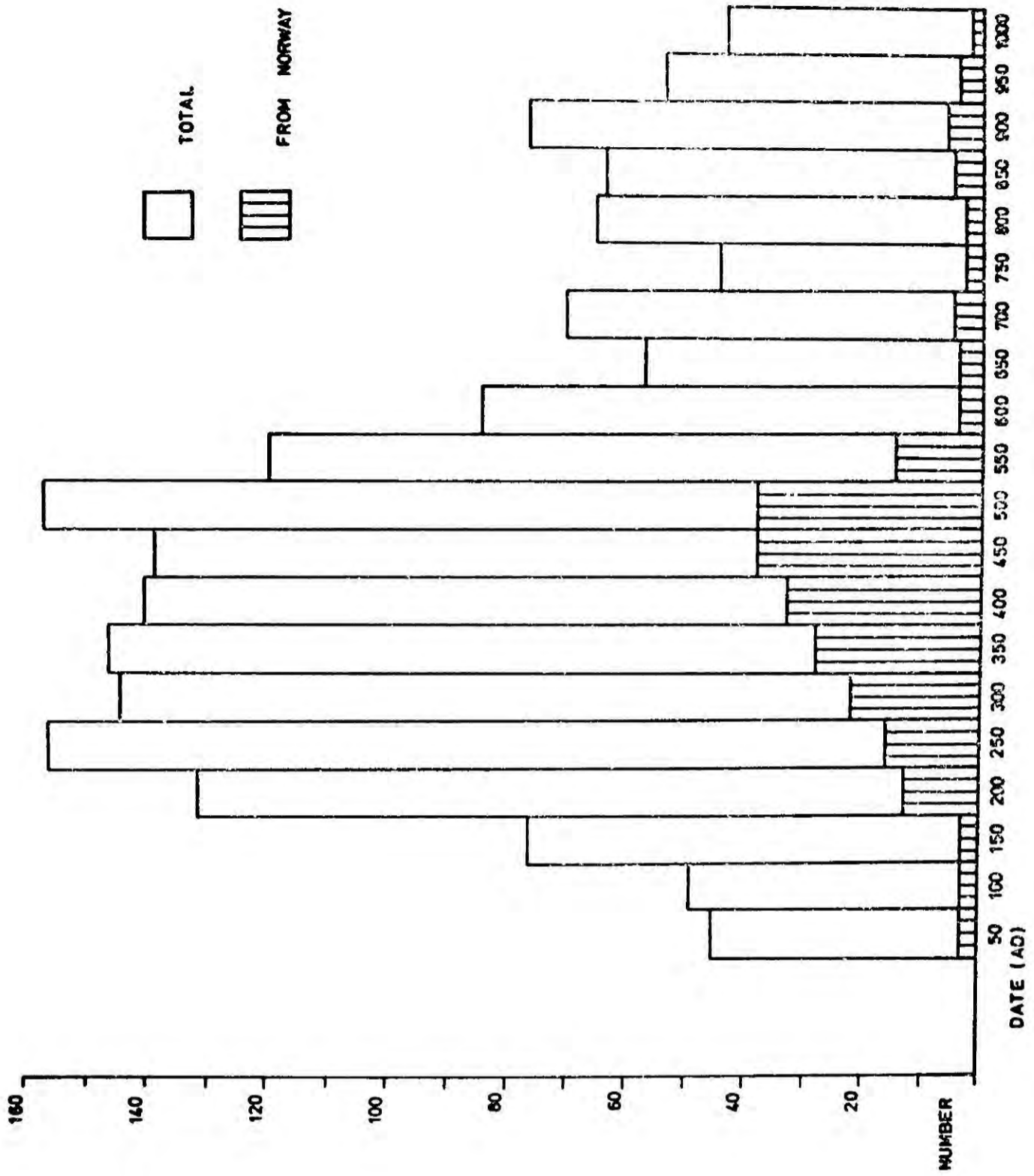


FIG 12.

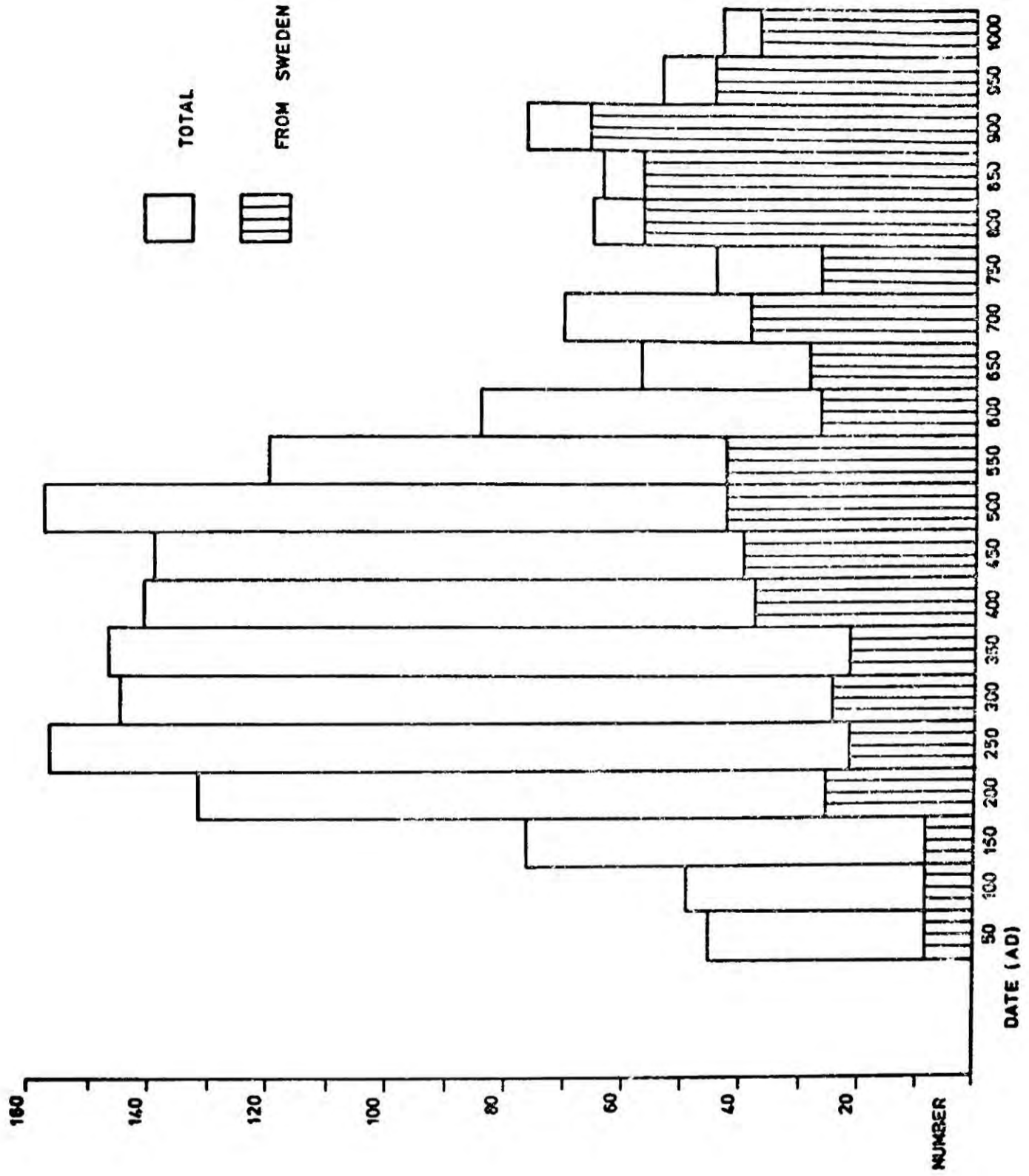


FIG 13.

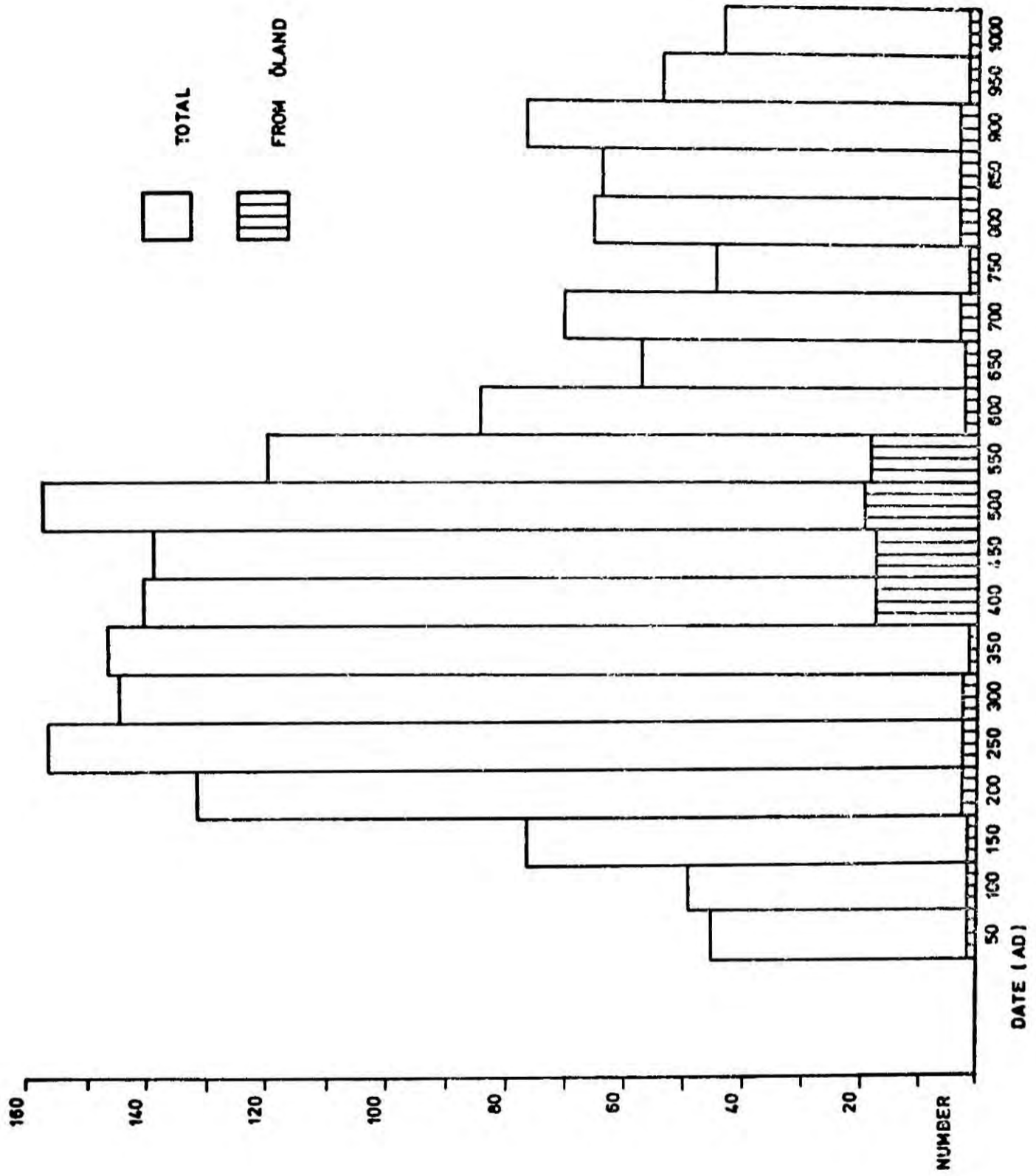


FIG 14.

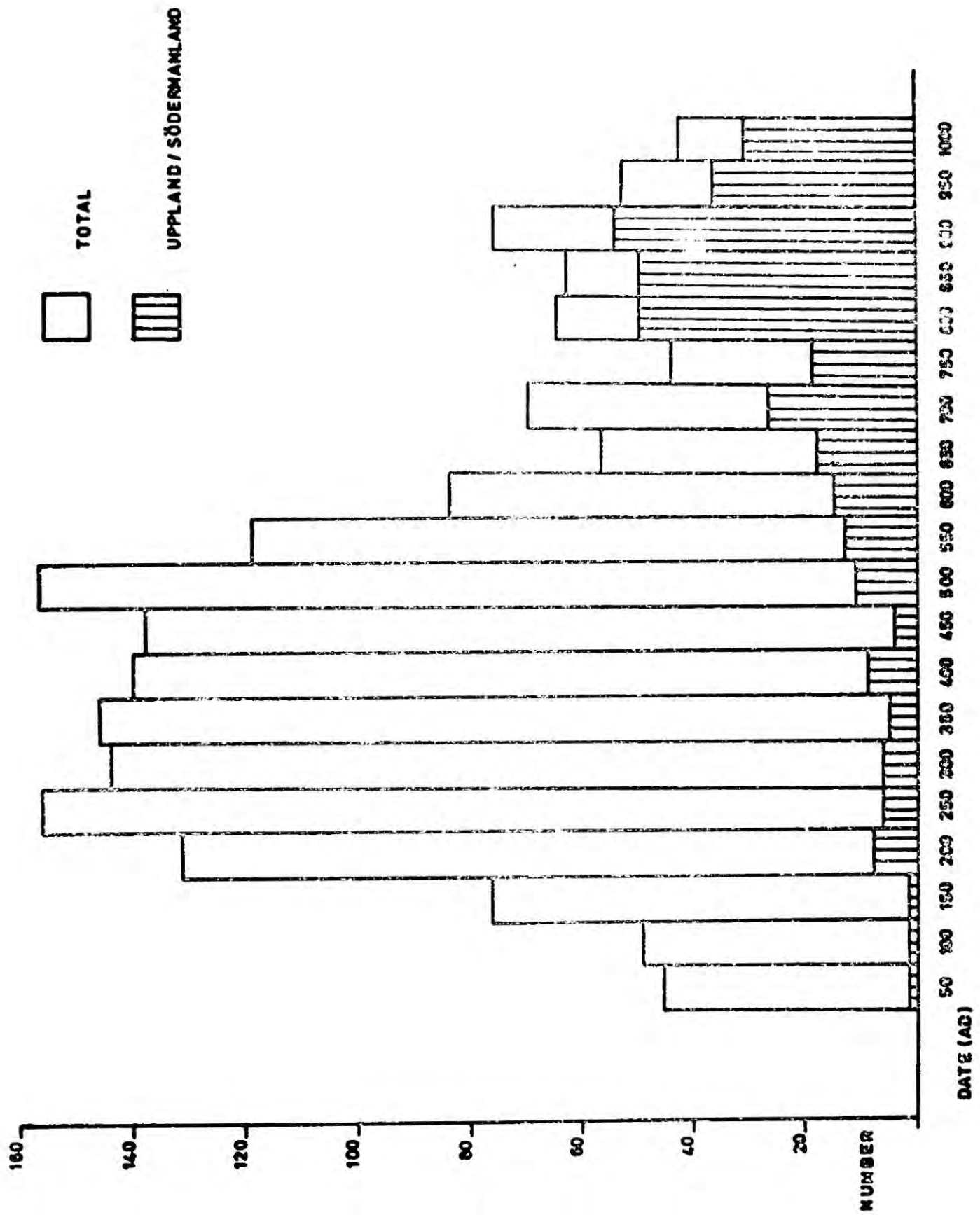
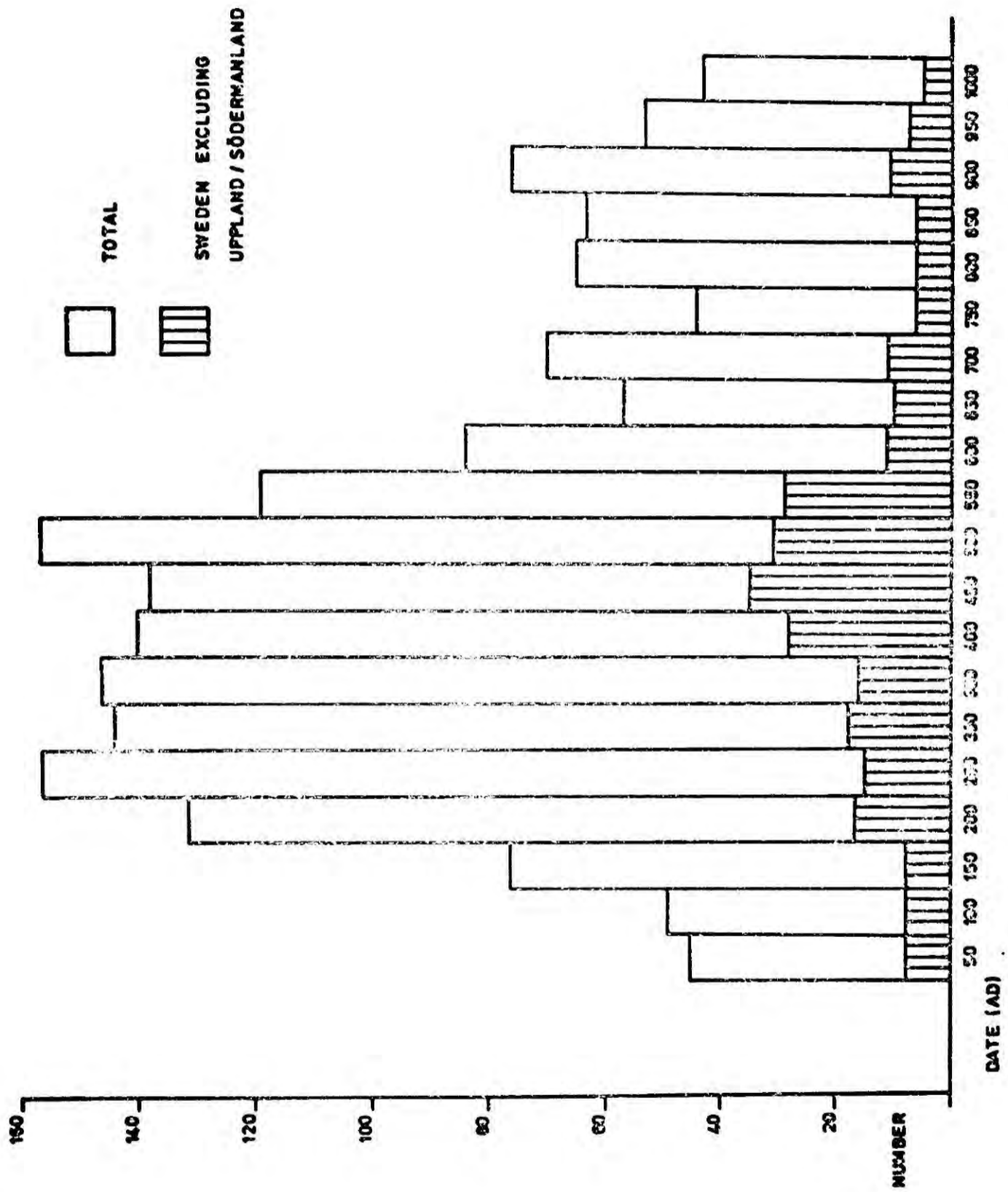


FIG 15.



Gotland and Öland between AD 400 - 600 and is followed in Uppland and Södermanland towards the end of the millennium. It can be listed as follows:

- | | | |
|-----|--------------------------|----------------|
| (1) | Bornholm and Denmark | ca. 50 - 400 |
| (2) | Norway and W. Sweden | ca. 200 - 500 |
| (3) | Gotland and Öland | ca. 400 - 600 |
| (4) | Uppland and Södermanland | ca. 800 - 1000 |

The dating ranges shown here are only approximate. The dates given represent the main frequency peaks as shown by the histograms, although clearly several of the areas contain items which exceed these periods. At this stage three possible explanations can be postulated. The first is that this movement is meaningless and only relates to burial customs which are known to have differed widely throughout Scandinavia. This possibility is examined below with regard to finds from both cremation and inhumation burials. The second explanation is that the movement reflects two distinct trade patterns, one via the North Sea and the other via the Baltic. This could conceivably explain the presence of glass in the North Sea areas of Bornholm, Denmark, Norway and Sweden in the earlier period brought about by trade contact with northern parts of the Continent. The later finds from Gotland, Öland and the E. Swedish regions which all have Baltic connections could equally be explained by a trade link via the Baltic itself. The idea of a changeover of finds from west to east has been criticised by Bakka who dismisses it as due to localised burial tradition ⁽¹⁾. One can cite examples which conflict with this such as Ekholm's distribution map of the Vestland Cauldrons

which appear in both east and west in the Migration period (2).

Furthermore the distribution of imported swords (Petersen's special types 1 and 2) have a distribution in both east and west in the Viking period (3). The only exception seems to be glass itself and this curious distribution was noticed by Arwidsson in 1942 in a study of Scandinavian glass from between AD 600 - 800. She showed the majority of these to be centred in the Baltic areas with most of the remainder in Norway (4). Bruce-Mitford subsequently indicated that at least two of these Norwegian glasses were Anglo-Saxon in origin (5).

Anomalous to this distribution are the Helgö glasses (not included in the histogram) which represent a rich and uninterrupted series of finds from the end of the fourth century to the early ninth century.

The final explanation may relate to the place of manufacture of the various vessels. The shift from west to east may have been brought about by the closure or establishment of glass houses either on the continent or in Scandinavia itself. The presence of large quantities of glass at places such as Helgö and Birka on the Baltic side or Kaupang on the west do tend to suggest that glass manufacturing in Scandinavia was a real possibility.

Burials and Glass Frequency

As burial traditions seem to have been so varied throughout Scandinavia it is essential to assess their relevance in the production of finds. If, as Bakka suggests, this movement is brought about directly by differences in burial custom then there is little point in continuing

the discussion. It is therefore important to review the relationship between the frequency of glasses from both cremation and inhumation burials in comparison to the frequency shown by the overall picture. This would ascertain whether or not localised burial traditions could have been responsible for the chronological shift. Figs 16 and 17 illustrate the chronological frequencies of glasses from cremations and inhumations respectively. They can be compared to figs 6 and 7 which show the frequency of complete and fragmentary items. The difference between the two sets is brought about firstly by the absence of items from culture layers in the former pair and secondly by an anomaly mentioned in chapter 2. This concerned the fact that glasses from cremations were not necessarily fragmentary and that glasses from inhumations were not necessarily complete.

It is significant that the number of items from either cremations or inhumations expressed as a ratio of the total number of items in Scandinavia is not constant throughout the period of time in question. For example the ratio of inhumation glasses to the total number of glasses around the year AD 300 is approximately 1:2 compared to a ratio of 1:11 around the year AD 650. Glasses from cremations have a similar variation. Had this ratio been constant one might have surmised that burial custom was not sufficiently varied throughout Scandinavia to have had a periodic effect on glass distribution and discovery. On the contrary, it must be maintained that variation of the burial custom was significant for our purposes and therefore must be taken into account. Its effect can now be examined with regard to regional variation in the frequency distribution.

FIG 16.

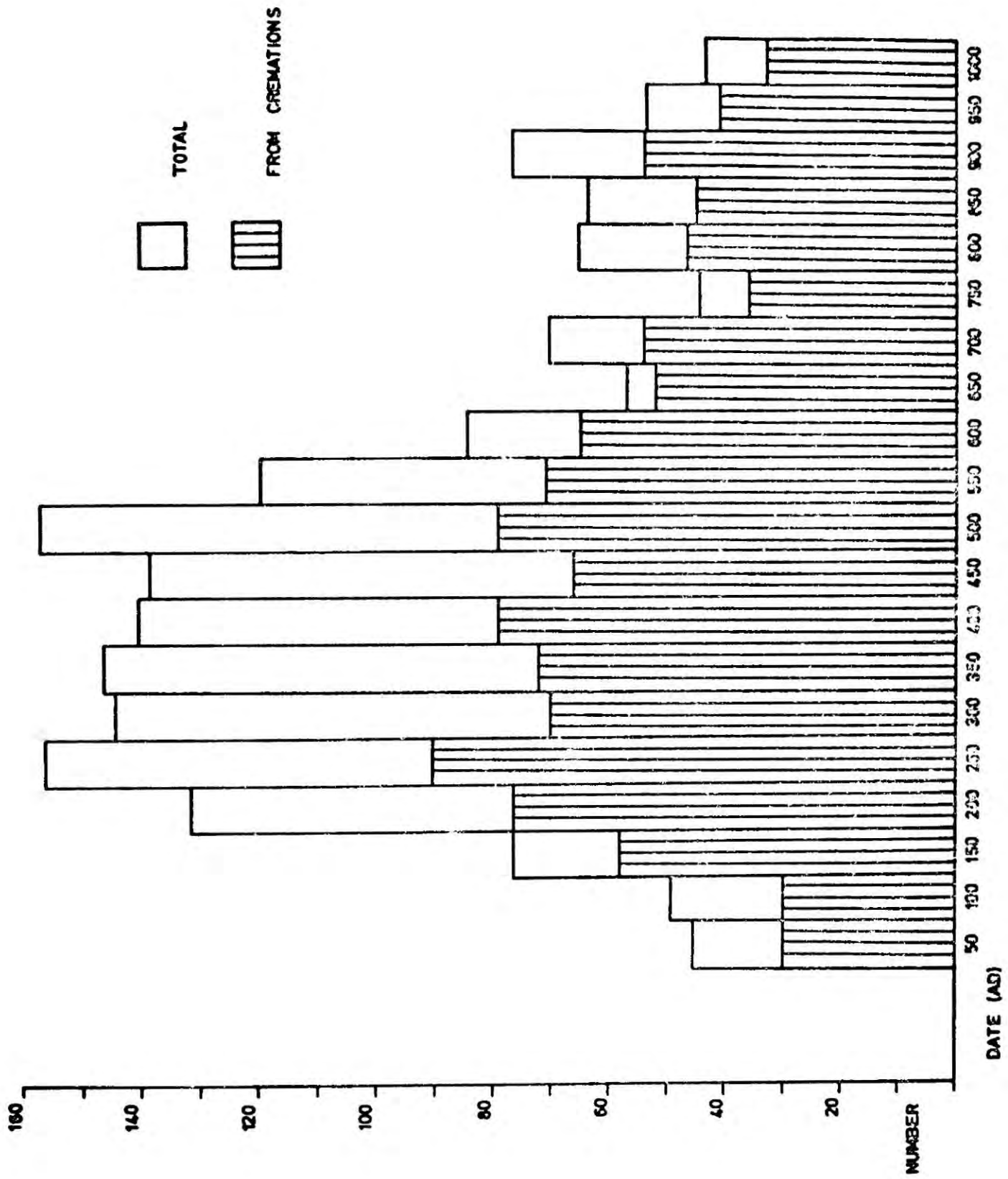
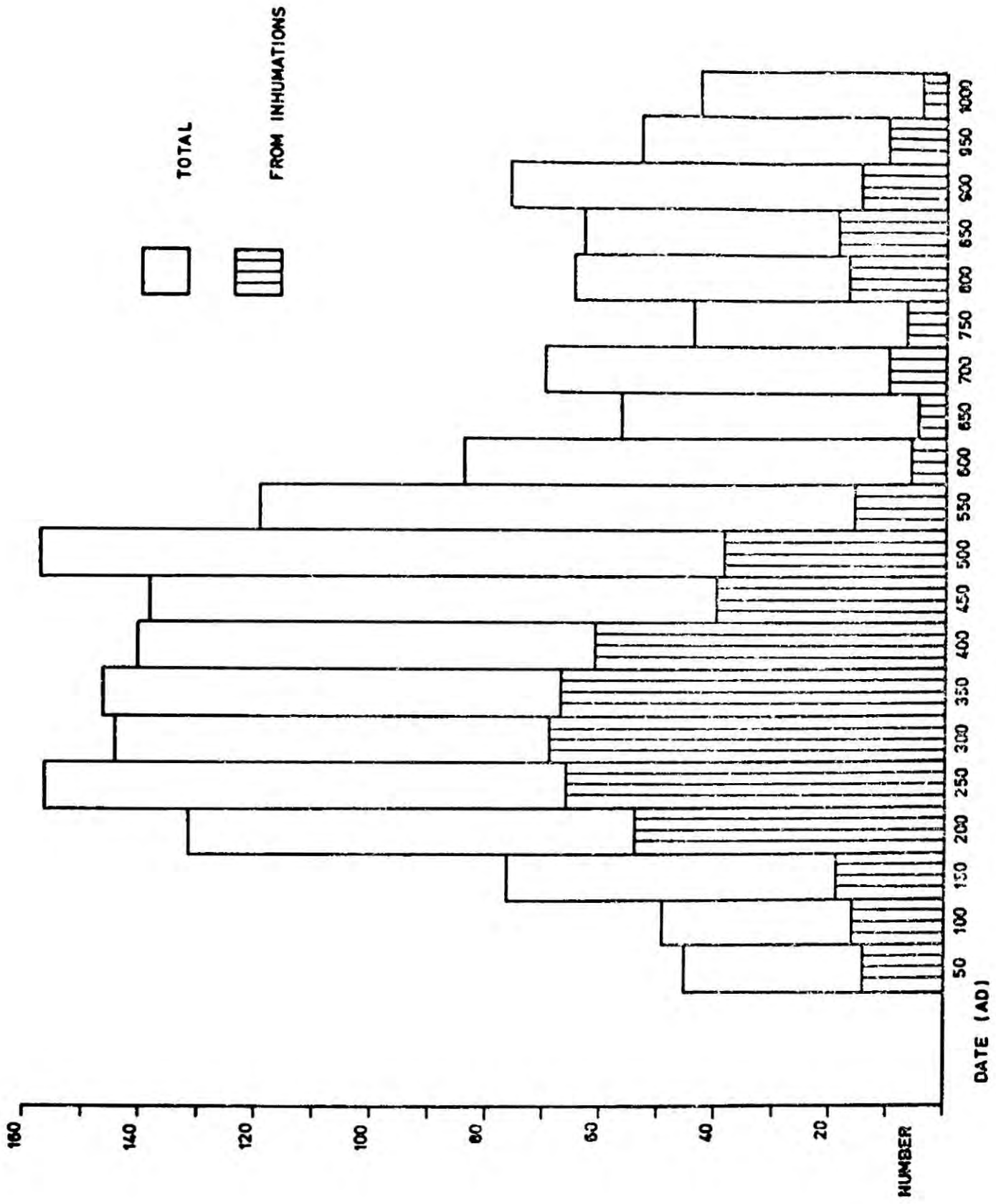


FIG 17.



Detailed study of the various countries and islands shows that the variation in burial custom is not geographically consistent. (Bornholm and Öland are excluded from this particular discussion as the items from both are too few in number to give a valid picture). The picture of Denmark (fig 18) shows a relatively constant ratio between the frequencies of items from cremations and inhumations. The Gotland and Sweden graphs (figs 19 and 20 respectively) indicate that cremation burial was significantly more common. In Sweden this difference exists throughout the entire country, including Uppland and Södermanland, and throughout the first millennium. In Norway (fig 21) on the other hand the process seems to be reversed. Items from inhumations are in the majority. These graphs indicate that variation in burial custom was both regional and chronological.

A cremation/inhumation shift can perhaps be outlined after AD 400. From that date the occurrence of inhumations declines except in Norway up until the beginning of the sixth century and re-emerges in Sweden towards the end of the millennium. This latter rise is more strictly confined to the Uppland and Södermanland regions from where most of the later Swedish finds appear. Cremation follows a different path increasing in Gotland towards the beginning of the seventh century and continuing to rise in Sweden (Uppland and Södermanland).

The significant point perhaps is that the practice of cremation and inhumation as shown by the glass finds and as defined by the frequency peaks follows a course which is not dissimilar to that of the total frequency shift outlined earlier. In general they compare well although

FIG 18.

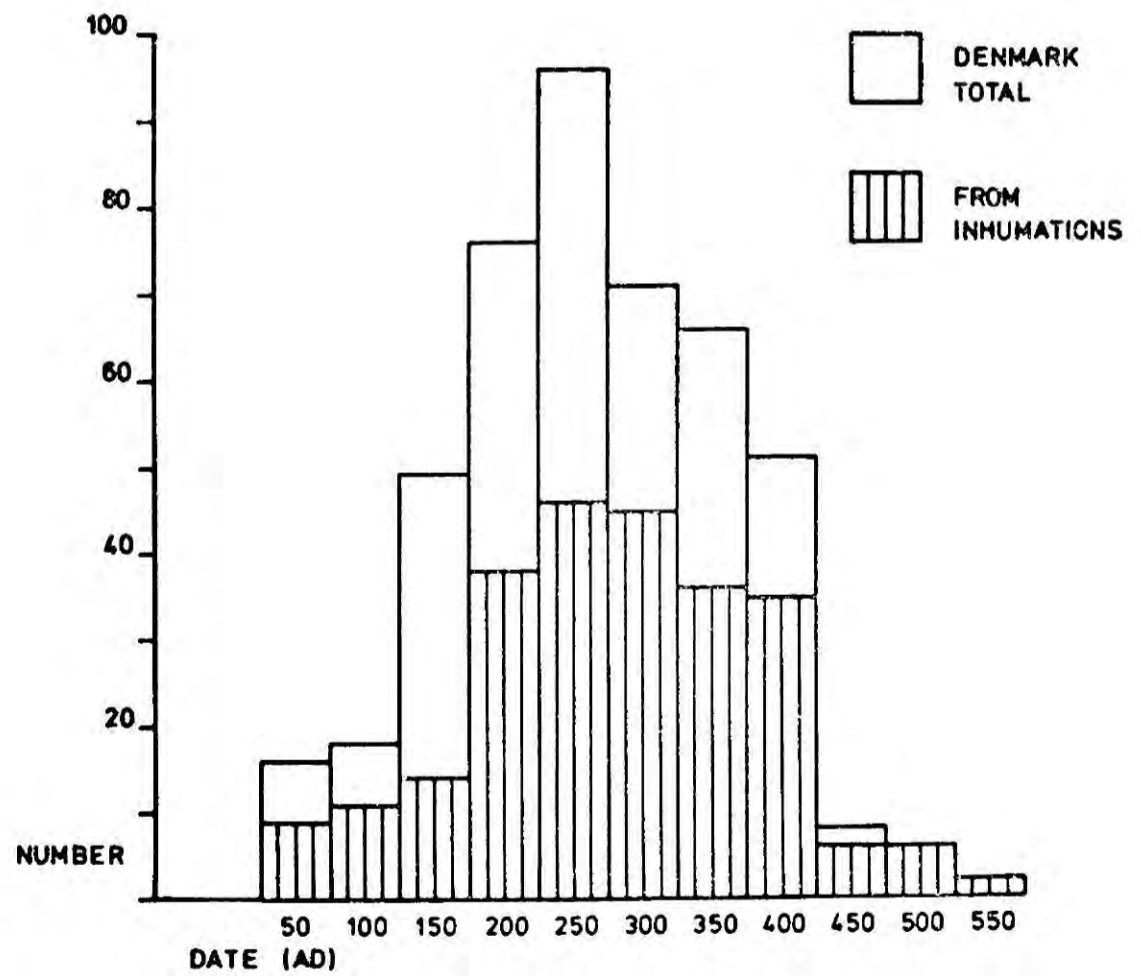
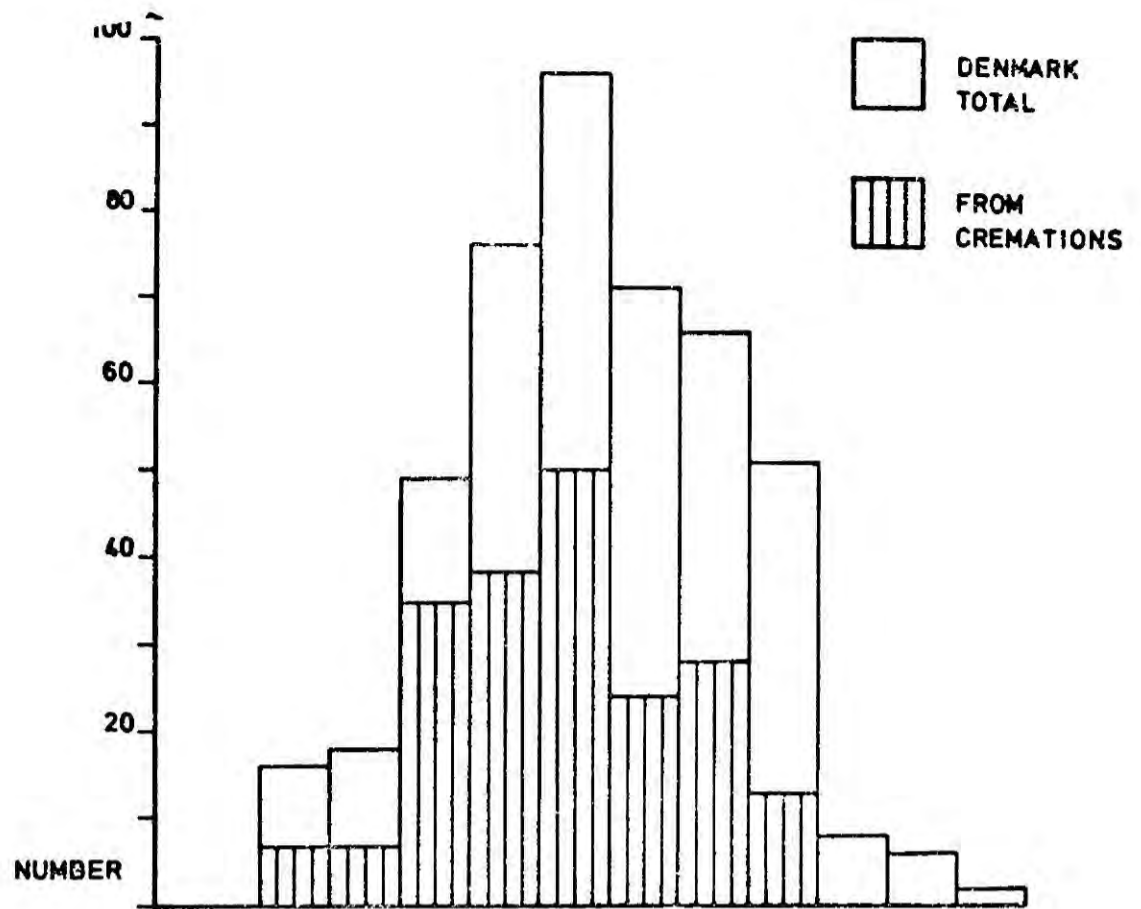


FIG 19.

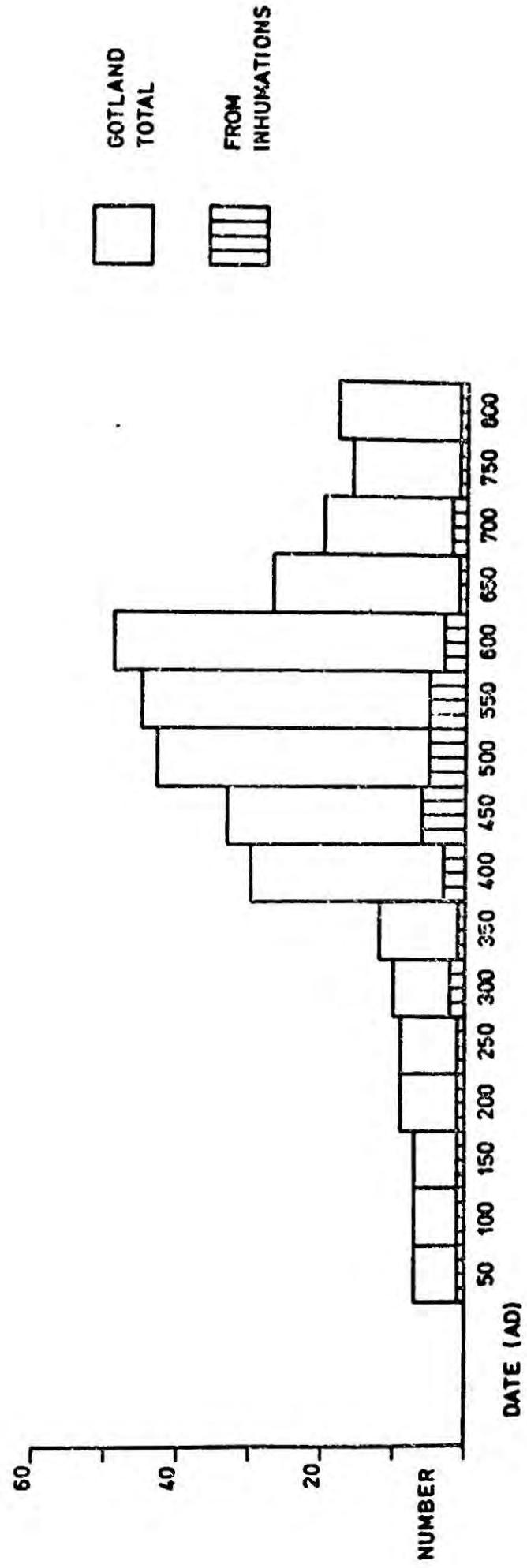
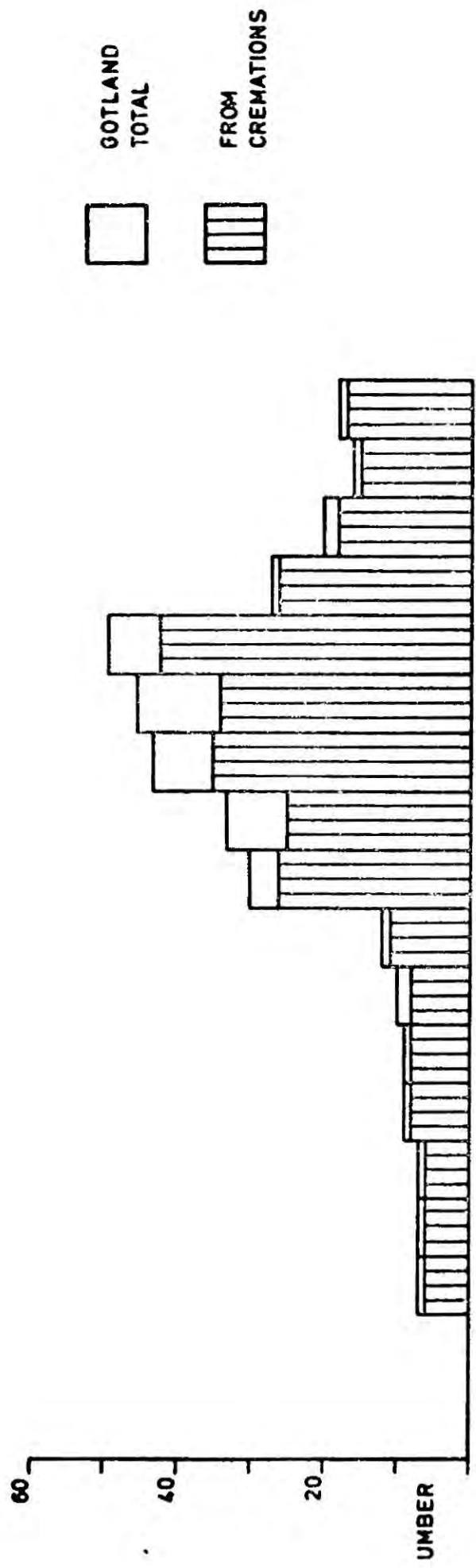


FIG 20.

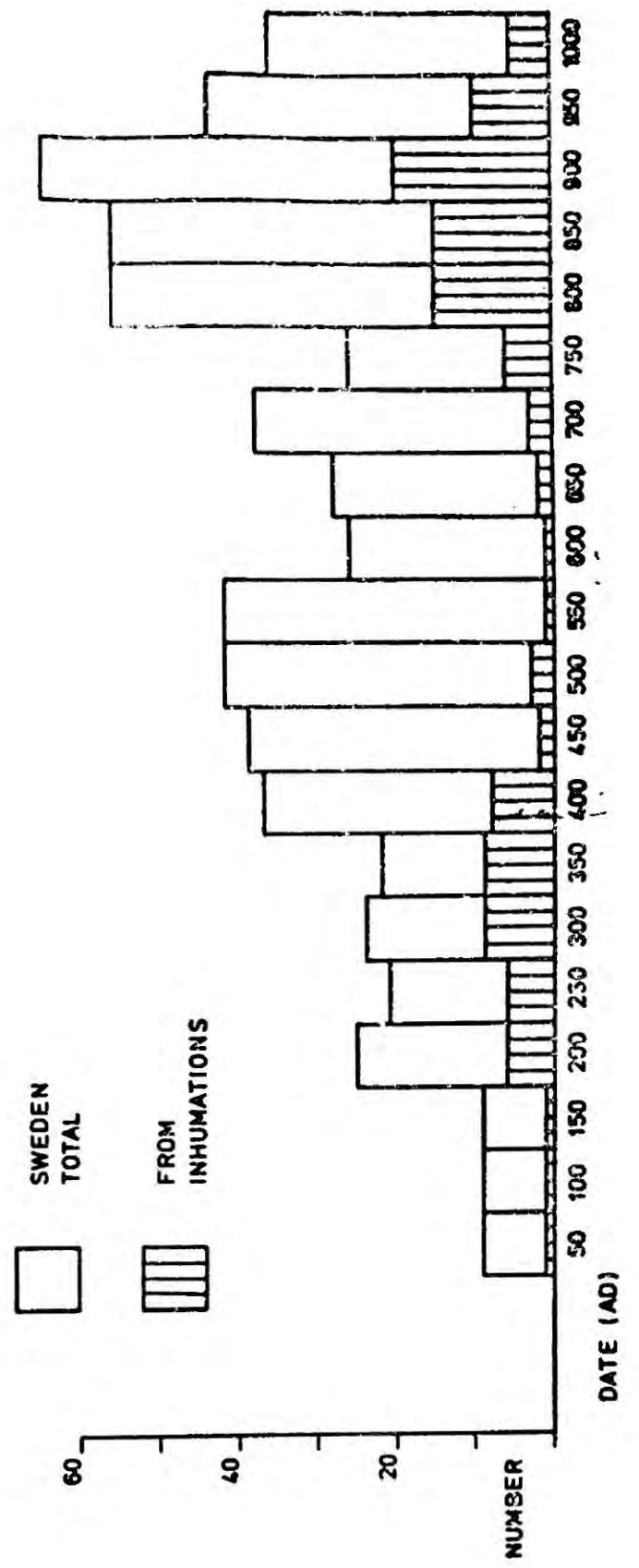
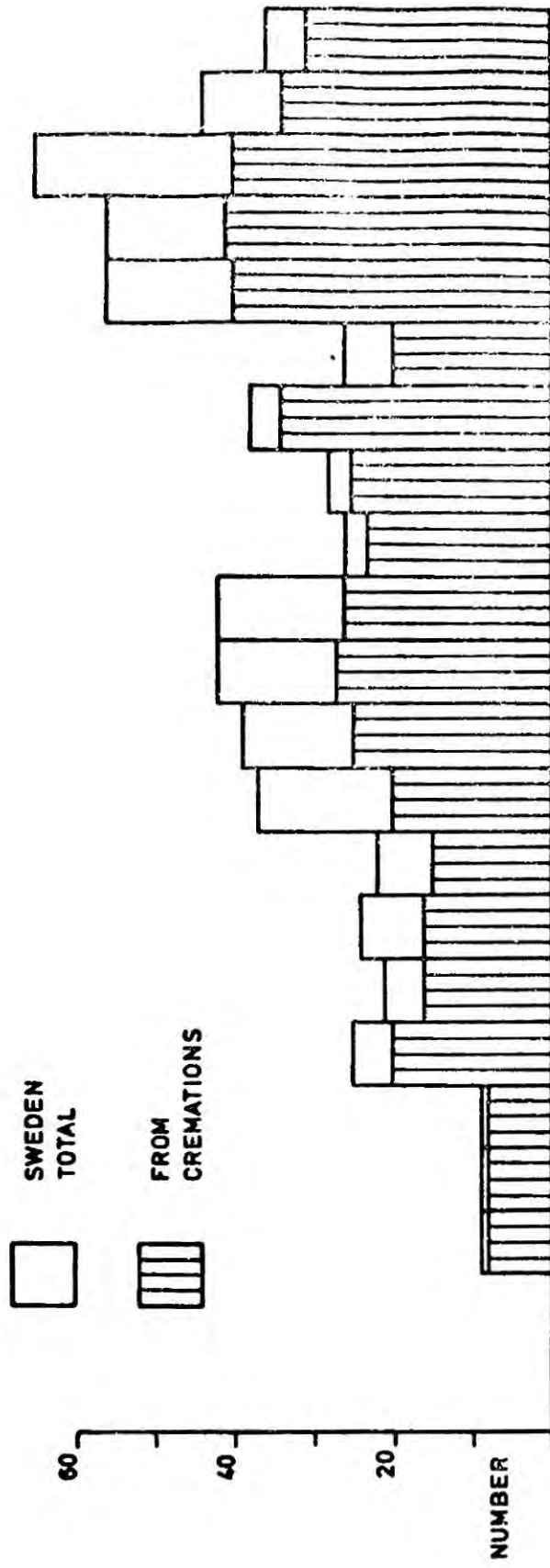
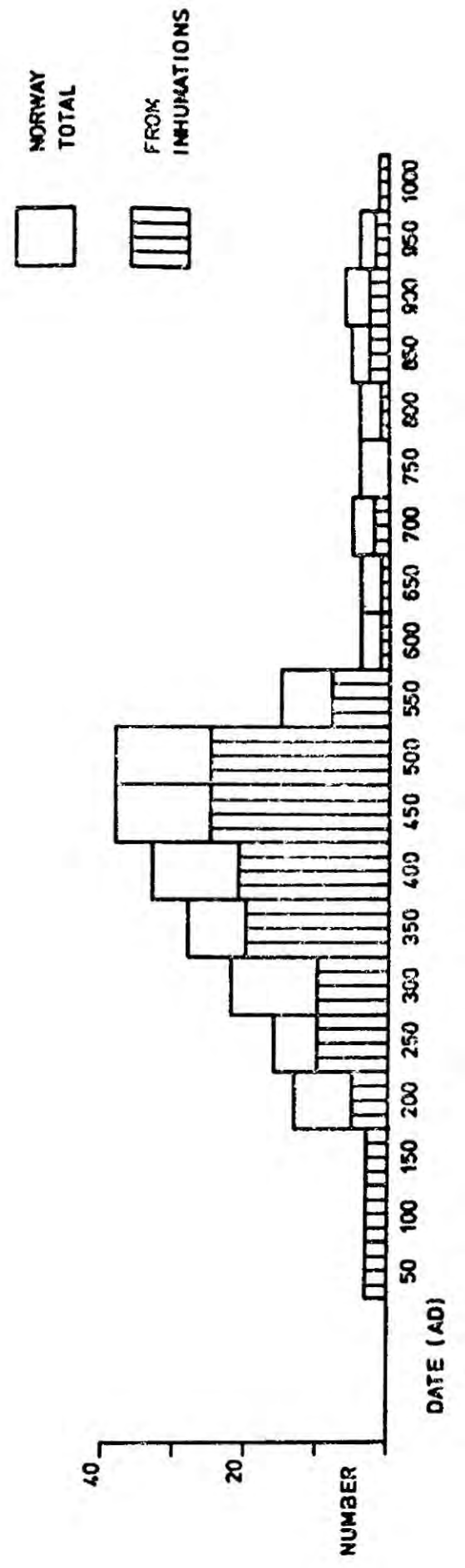
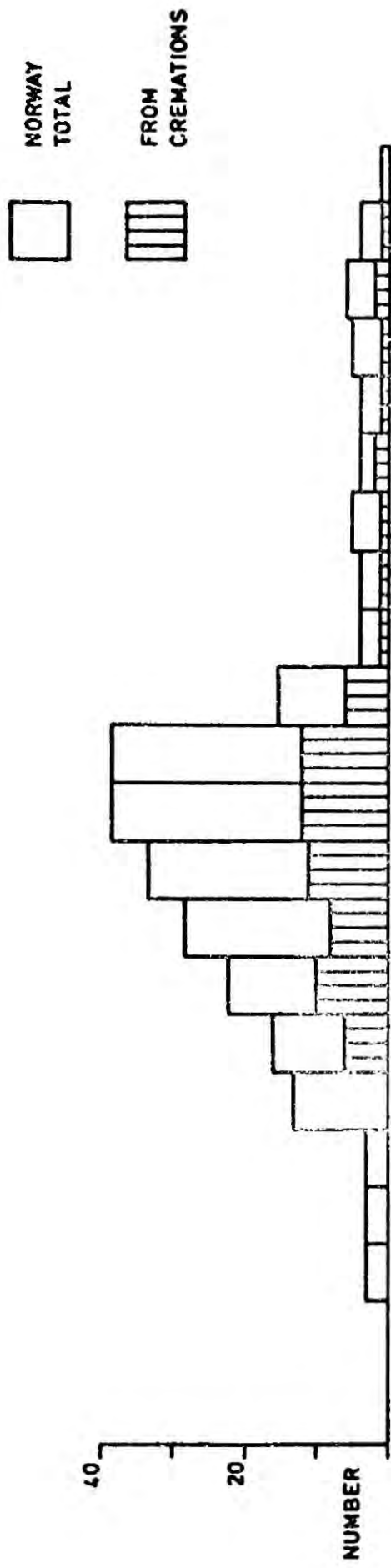


FIG 21.



differing at certain points. The conclusion is that the total frequency shift in the most part, reflects specific phases of particular burial customs. For example, the west Scandinavian distribution of glass in the early half of the millennium can be partly explained by the peak of inhumation burials in Norway at a time when the rest of Scandinavia tended to follow a cremation ritual. What cannot be explained by burial custom is the dearth of glass at other periods of time in the various countries. Denmark offers virtually no glass after ca. AD 500 and other factors are needed to explain this. Gotland ceases to produce glass beyond the eighth century. Norway yields only a few examples outside Kaupang in the second half of the millenium and these are equally divided between the two types of burial, thus suggesting that burial type was not responsible for the lack of items. Burial practice alone cannot explain this phenomenon.

It could be argued that absence of glass is brought about by a tendency for glass not to be inserted as grave goods in either type of burial and that our lack of glass is not due to a scarcity at the time but merely that the current burial practice was a simple and less elaborate one. According to the graphs therefore these less elaborate burials occurred in Denmark after ca. AD 400, in Norway after ca. AD 550, in Gotland after ca. AD 800 and in W. Sweden also after ca. AD 800. This may seem a valid hypothesis from a glass point of view but it cannot hold weight against the distribution of other artefacts appearing in burials in these periods and in the countries in question. The conclusion from this is simply that although there was variation in

burial custom throughout Scandinavia on both a local and national level, and although in certain instances this can be related to the frequency of finds, in no way can it explain the preponderance of glass in certain places and at certain times nor indeed account for the complete absence of glass at other times. Other factors must be examined to find a solution.

Typological Groupings

The cause of the frequency shift from west to east appears to have its roots other than in trade and burial variation. The next stage is to examine the chronological frequency distribution of the various typological elements and to assess any significant pointers which emerge. This analysis was undertaken by comparing appropriate combinations from the various typological columns and establishing their chronological and geographical distributions. The eleven typological columns (columns A - K inclusive) from the lists in Chapter 5 were grouped in such a way as to form significant units of elements. The first combined the three columns (A, B and C) which together represented the intrinsic shape of the vessel; the form, the proportion and the profile. The second concerned simply the base elements (column D). The third combined columns E and F to denote rim elements. Column G was used to denote the "other features" (i.e. claws). The fifth unit combined columns H and J to give the basic decorative qualities of the vessel. Column I was used to denote the orientation of the field of decoration, and finally the seventh unit using column K was used to denote colouring characteristics.

Form, Proportion and Profile

A division of these three elements was then made into the appropriate numerical combinations which appeared in the lists, i.e. 2,3,1, 2,4,1, 3,1,1 etc. In all, thirty-three different combinations appeared and this represented the complete or restorable items from the catalogue. These combinations were plotted graphically in the same way as the frequencies plotted above taking values every 50 years. The results are shown on figs 22 - 25. Again, using chronology as the primary grouping factor it seems that the chronological ranges of these combinations are distinct, and that they fall broadly into four major categories (A - D) defined by starting dates. These are listed below together with the countries and islands represented in that combination and their individual date ranges. From a statistical point of view some of the numbers are rather low but on an overall basis the picture must be considered a valid one.

Group A contains combinations which originated in the earliest part of the millennium.

<u>Combination</u>	<u>Chronological Span</u>	<u>Numbers of items per area</u>		
2,3,1	ca. AD 50 - 550	Denmark	3	(AD 50 - 300)
		Norway	7	(AD 350 - 550)
		W. Sweden	3	(AD 50 - 500)
2,4,1	ca. AD 50 - 900	Denmark	10	(AD 50 - 500)
		Gotland	4	(AD 400 - 600)
		Norway	10	(AD 200 - 550, 850 - 900)
		W. Sweden	6	(AD 300 - 600)

<u>Combination</u>	<u>Chronological Span</u>	<u>Numbers of items per area</u>	
3,1,1	ca. AD 50 - 200	Norway	1 (AD 50 - 200)
3,1,5	ca. AD 50 - 500	Denmark	2 (AD 100 - 200)
		Norway	1 (AD 400 - 500)
3,2,6	ca. AD 50 - 350	Denmark	6 (AD 50 - 350)
3,6,8	ca. AD 50 - 200	W. Sweden	1 (AD 50 - 200)
4,2,7	ca. AD 50 - 850	Bornholm	1 (AD 200 - 400)
		Denmark	11 (AD 50 - 400)
		W. Sweden	1 (AD 50 - 400)
		E. Sweden	1 (AD 800 - 850)
6,3,3	ca. AD 50 - 1000	Denmark	2 (AD 50 - 550)
		Gotland	1 (AD 550 - 600)
		Norway	1 (AD 850 - 900)
		E. Sweden	2 (AD 700 - 1000)

Total dating range AD 50 - 1000. Total number of items used 74.

Group B contains combinations which originated in the third century.

<u>Combination</u>	<u>Chronological Span</u>	<u>Numbers of items per area</u>	
2,3,5	ca. AD 200 - 500	Denmark	1 (AD 400 - 500)
		Norway	1 (AD 400 - 500)
		W. Sweden	1 (AD 200 - 400)
2,3,7	ca. 200 - 450	Denmark	7 (AD 200 - 400)
		Norway	3 (AD 200 - 450)

<u>Combination</u>	<u>Chronological Span</u>	<u>Numbers of items per area</u>	
2,4,4	ca. 200 - 400	Denmark	1 (AD 200 - 400)
2,5,7	ca. AD 200 - 400	Denmark	1 (AD 200 - 400)
2,6,1	ca. AD 200 - 600	Denmark	1 (AD 450 - 550)
		Gotland	1 (AD 550 - 600)
		Norway	4 (AD 200 - 550)
2,6,4	ca. AD 200 - 400	Denmark	3 (AD 200 - 400)
3,2,7	ca. AD 250 - 300	Denmark	1 (AD 250 - 300)
4,2,5	ca. AD 200 - 450	Bornholm	1 (AD 200 - 400)
		Denmark	4 (AD 200 - 450)
		Oland	1 (AD 200 - 300)
4,2,6	ca. AD 200 - 400	Denmark	4 (AD 200 - 400)
		Norway	1 (AD 200 - 400)
		W. Sweden	1 (AD 200 - 400)
4,3,6	ca. 200 - 500	W. Sweden	2 (AD 200 - 500)
6,6,3	ca. AD 300 - 400	Denmark	2 (AD 300 - 400)

Total dating range AD 200 - 600. Total number of items used 41.

Group C contains combinations which originated between AD 400 - 550

<u>Combination</u>	<u>Chronological Span</u>	<u>Number of items per area</u>	
2,5,1	ca. AD 400 - 800	Gotland	1 (AD 500 - 600)
		Norway	2 (AD 400 - 550)
		E. Sweden	3 (AD 750 - 800)
2,5,5	ca. AD 500 - 600	Gotland	1 (AD 500 - 600)
3,1,6	ca. AD 500	Norway	1 (AD 500)
3,2,8	ca. AD 400 - 450	Denmark	1 (AD 400 - 450)
3,4,3	ca. AD 550 - 600	Gotland	1 (AD 550 - 600)
3,4,5	ca. AD 400 - 450	Norway	1 (AD 400 - 450)
5,6,7	ca. AD 400 - 550	Denmark	1 (AD 400 - 550)

Total dating range AD 400 - 800. Total number of items used 12.

Group D contains combinations which originated after ca. AD 650

<u>Combination</u>	<u>Chronological Span</u>	<u>Number of items per area</u>	
2,3,2	ca. AD 800 - 1000	E. Sweden	8 (AD 800 - 1000)
2,4,2	ca. AD 800 - 900	E. Sweden	2 (AD 800 - 900)
3,5,6	ca. AD 750	E. Sweden	1 (AD 750)
4,2,1	ca. AD 650 - 750	Gotland	1 (AD 700)
		E. Sweden	1 (AD 650 - 750)
4,2,3	ca. AD 900 - 1000	E. Sweden	2 (AD 900 - 1000)

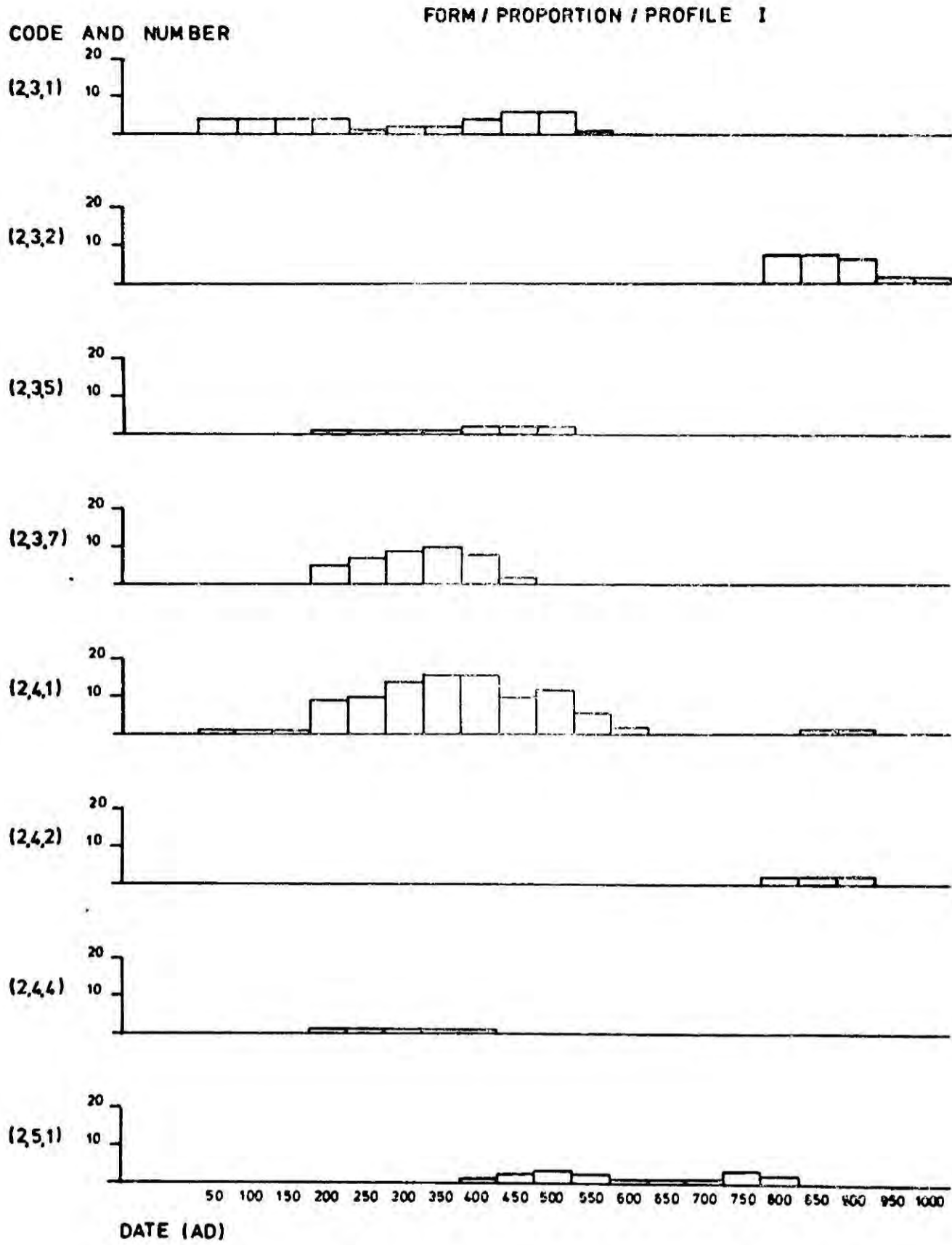
<u>Combination</u>	<u>Chronological Span</u>	<u>Number of items per area</u>
6,2,3	ca. AD 950	E. Sweden 1 (AD 950)
6,4,3	ca. AD 800 - 950	Norway 1 (AD 850 - 950)
		E. Sweden 1 (AD 800 - 900)

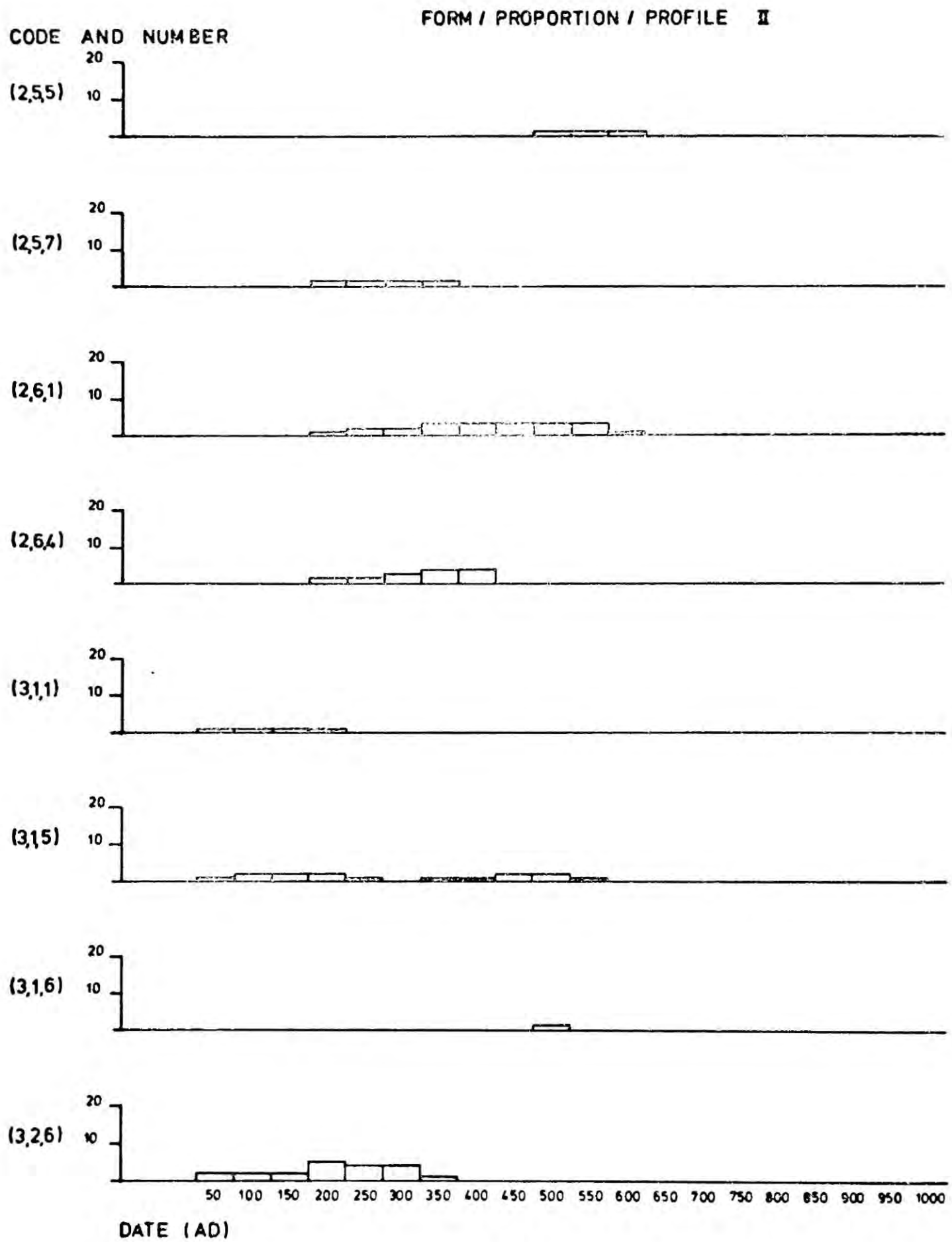
Total dating range AD 650 - 1000. Total number of items used 18.

The four groups contain a total of 145 items. The frequency shift from west to east is still apparent. However, despite this there are indications that certain combinations existed on both sides of Scandinavia. The general picture of finds from the later part of the millennium appearing on the Baltic side is essentially maintained and reflects the opposite picture of the earlier finds from the western side. Seven of these combinations appear in both east and west, 2,4,1; 2,5,1; 2,6,1; 4,2,5; 4,2,7; 6,3,3 and 6,4,3. These are re-grouped below in terms of geographical distribution.

<u>Combination</u>	<u>Western Items</u>		<u>Eastern Items</u>	
2,4,1	Denmark	10	Gotland	4
	Norway	10		
	W. Sweden	6		
2,5,1	Norway	2	Gotland	1
			E. Sweden	3
2,6,1	Denmark	1	Gotland	1
	Norway	4		

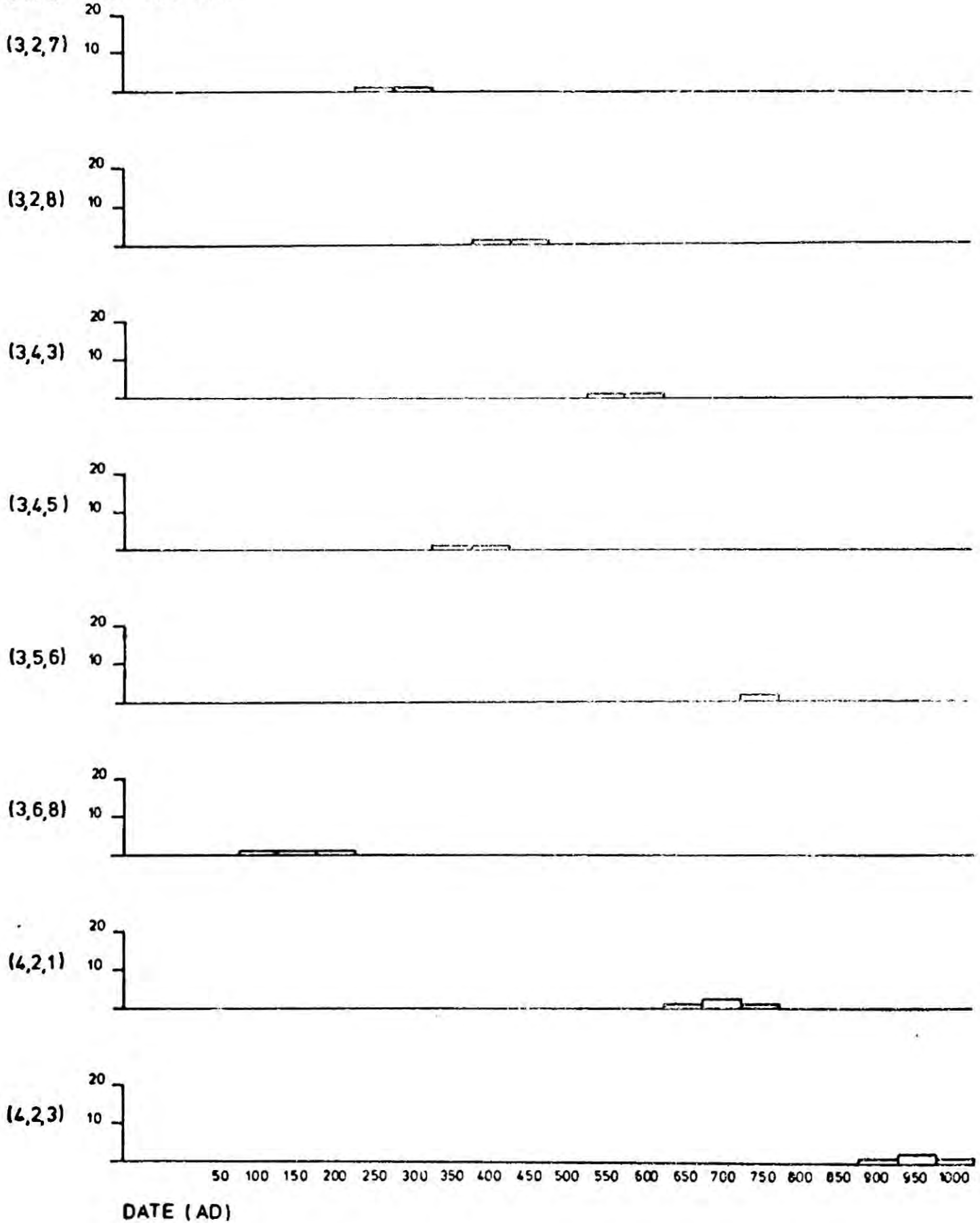
FIG 22.

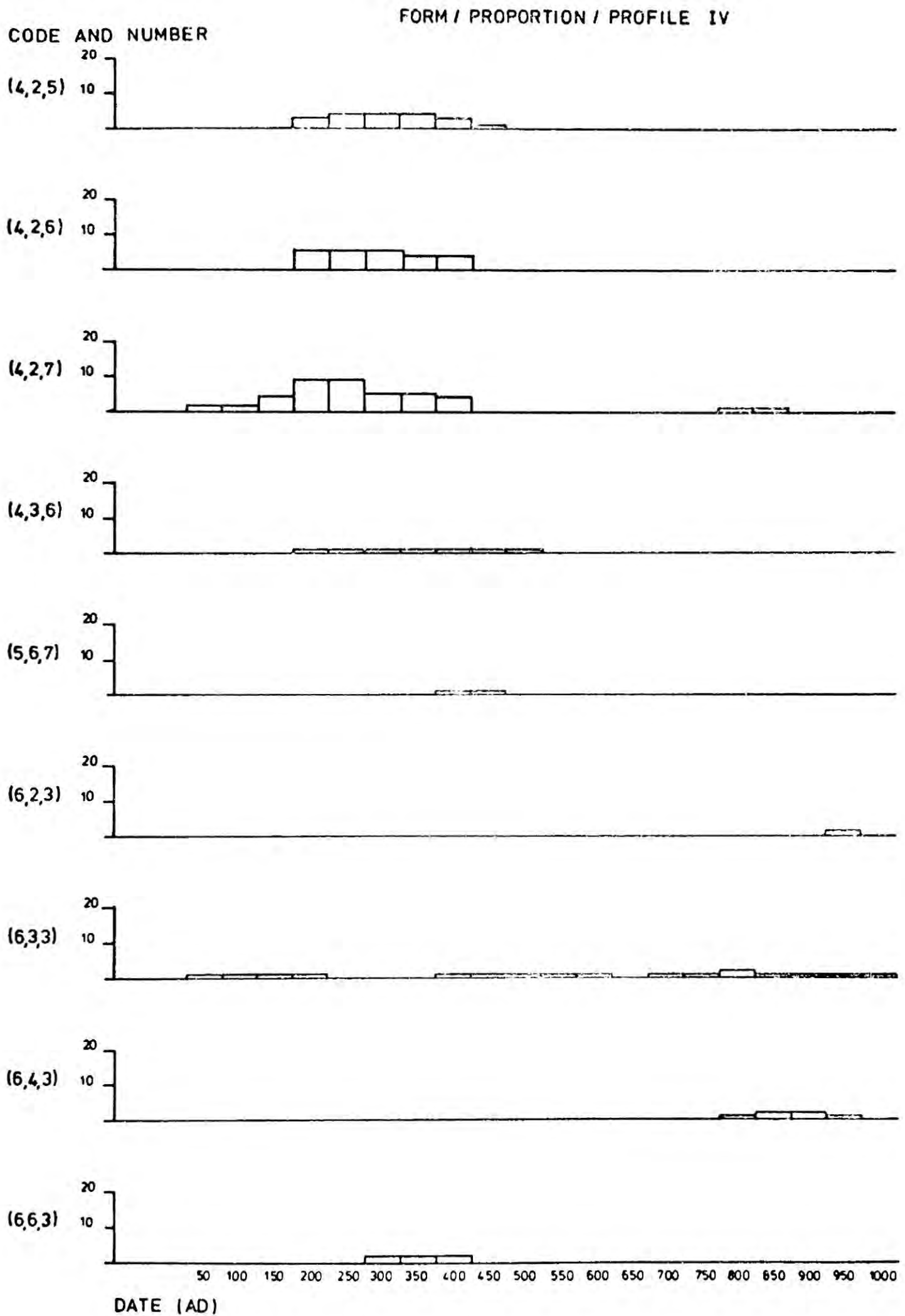




FORM / PROPORTION / PROFILE III

CODE AND NUMBER





<u>Combination</u>	<u>Western Items</u>		<u>Eastern Items</u>	
4,2,5	Bornholm	1	Öland	1
	Denmark	4		
4,2,7	Bornholm	1	E. Sweden	1
	Denmark	11		
	W. Sweden	1		
6,3,3	Denmark	2	Gotland	1
	Norway	1	E. Sweden	2
6,4,3	Norway	1	E. Sweden	1

As far as the dating is concerned we can dismiss 4,2,7 and 4,2,5 on the grounds that chronologically the eastern and western finds are too far apart and perhaps represent 'heirloom' survivals rather than a parallel distribution. The others however can generally be said to have appeared in both east and west at approximately the same time. Although statistically it would be dangerous to draw any conclusions from these few instances it can be pointed out that the majority of these combinations appearing in both east and west can be dated to a time somewhere in the Vendel Period.

Base of Vessel

This column (column D) can be treated individually. Six variables were plotted and can be seen on fig 26. They can be sorted chronologically into three groups (A - C) and these are listed below.

Group A contains two types which originated in the earliest part of the millennium and appear to cease after ca. AD 400.

<u>Code</u>	<u>Chronological Span</u>	<u>Number of items per area</u>	
5	ca. AD 50 - 400	Bornholm	2 (AD 200 - 400)
		Denmark	3 (AD 50 - 400)
		Norway	2 (AD 200 - 400)
		W. Sweden	2 (AD 200 - 400)
3	ca. AD 50 - 400	Bornholm	1 (AD 50 - 400)
		Denmark	16 (AD 50 - 400)
		Norway	3 (AD 200 - 400)
		Öland	1 (AD 200 - 300)

Total dating range AD 50 - 400. Total number of items used 30.

Group B contains those items which appear to cover the span of the millennium.

<u>Code</u>	<u>Chronological Span</u>	<u>Number of items per area</u>	
1	ca. AD 50 - 1000	Bornholm	1 (AD 200 - 400)
		Denmark	15 (AD 50 - 550)
		Gotland	6 (AD 550 - 900)
		Norway	11 (AD 50 - 1000)
		W. Sweden	1 (AD 50 - 200)
		E. Sweden	11 (AD 500 - 1000)
		Öland	3 (AD 50 - 550)

<u>Code</u>	<u>Chronological Span</u>	<u>Number of items per area</u>	
2	ca. AD 50 - 1000	Bornholm	2 (AD 200 - 500)
		Denmark	16 (AD 50 - 500)
		Gotland	7 (AD 400 - 800)
		Norway	15 (AD 200 - 900)
		W. Sweden	5 (AD 50 - 550)
		E. Sweden	8 (AD 650 - 1000)
		Öland	1 (AD 200 - 300)
6	ca, AD 50 - 1000	Bornholm	1 (AD 50 - 400)
		Denmark	17 (AD 50 - 550)
		Gotland	3 (AD 500 - 800)
		Norway	29 (AD 200 - 1000)
		W. Sweden	6 (AD 200 - 500)
		E. Sweden	19 (AD 650 - 1000)

Total dating range AD 50 - 1000. Total number of items used 177.

Group C contains those items which originated in the third century.

<u>Code</u>	<u>Chronological Span</u>	<u>Number of items per area</u>	
4	ca. AD 200 - 550	Denmark	7 (AD 200 - 500)
		Norway	1 (AD 400 - 550)
		W. Sweden	1 (AD 200 - 400)

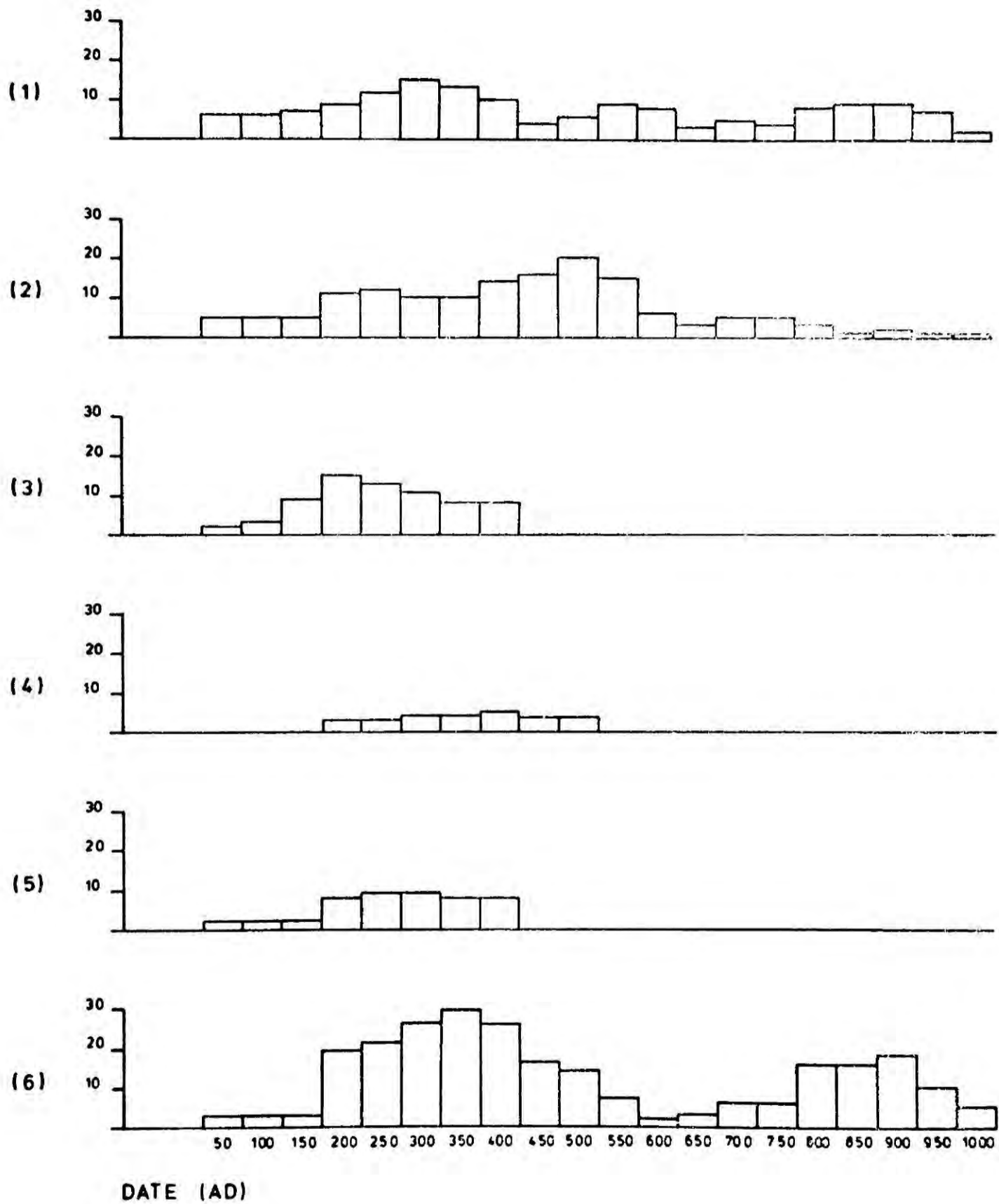
Total dating range AD 200 - 500. Total number of items used 9.

The three groups contain a total of 216 items. Groups A and C contain base forms which are exclusive to western Scandinavia and to

FIG 26.

CODE AND NUMBER

BASE ELEMENTS



the early part of the period. Group B however contains items which are common to both sides of Scandinavia. The significant fact however is that the dating range which is common to both sides again approximately coincides with the Vendel period. Although there is still a noticeable shift from west to east some form of overlap period exists in the middle of the millennium.

Rim Elements

The combinations of the various rim elements (columns E and F in the typological lists) can be divided into three groups (A - C) defined by the dates at which they originated (figs. 27 and 28).

Group A contains those combinations which originated in the earliest part of the millennium.

<u>Combination</u>	<u>Chronological Span</u>	<u>Number of items per area</u>
1,2	ca. AD 50 - 550	Denmark 13 (AD 50 - 400)
		Norway 6 (AD 200 - 550)
		W. Sweden 4 (AD 50 - 400)
1,3	ca. AD 50 - 600	Denmark 8 (AD 50 - 500)
		Gotland 2 (AD 500 - 600)
		Norway 24 (AD 250 - 550)
		W. Sweden 5 (AD 200 - 500)
		Öland 1 (AD 200 - 400)
2,2	ca. AD 50 - 1000	Denmark 3 (AD 150 - 400)
		Norway 4 (AD 50 - 500, 900-1000)

<u>Combination</u>	<u>Chronological Span</u>	<u>Number of items per area</u>	
4,2	ca. AD 50 - 1000	Bornholm	2 (AD 50 - 400)
		Denmark	13 (AD 50 - 500)
		Gotland	5 (AD 400 - 600)
		Norway	3 (AD 350 - 400, 700 - 1000)
4,3	ca. AD 50 - 1000	Bornholm	2 (AD 200 - 400)
		Denmark	17 (AD 50 - 400)
		Gotland	2 (AD 550 - 800)
		Norway	11 (AD 50 - 1000)
		W. Sweden	5 (AD 300 - 900)
		E. Sweden	7 (AD 650 - 1000)
		Öland	2 (AD 50 - 200)
5,3	ca. AD 50 - 1000	Bornholm	1 (AD 400 - 500)
		Denmark	6 (AD 50 - 400)
		Gotland	3 (AD 400 - 600)
		W. Sweden	2 (AD 200 - 600)
		E. Sweden	18 (AD 500 - 1000)
		Öland	3 (AD 400 - 550)

Total dating range AD 50 - 1000. Total number of items used 172.

Group B contains those combinations which originated in the second century.

<u>Combination</u>	<u>Chronological Span</u>	<u>Total number of items per area</u>	
5,1	ca. AD 150 - 1000	Denmark	1 (AD 150 - 250)
		E. Sweden	3 (AD 650 - 1000)

<u>Combination</u>	<u>Chronological Span</u>	<u>Total number of items per area</u>	
5,2	ca. AD 150 - 1000	Denmark	11 (AD 150 - 550)
		Gotland	3 (AD 400 - 800)
		Norway	10 (AD 300 - 1000)
		W. Sweden	2 (AD 400 - 500)
		E. Sweden	7 (AD 650 - 1000)
		Öland	2 (AD 300 - 550)

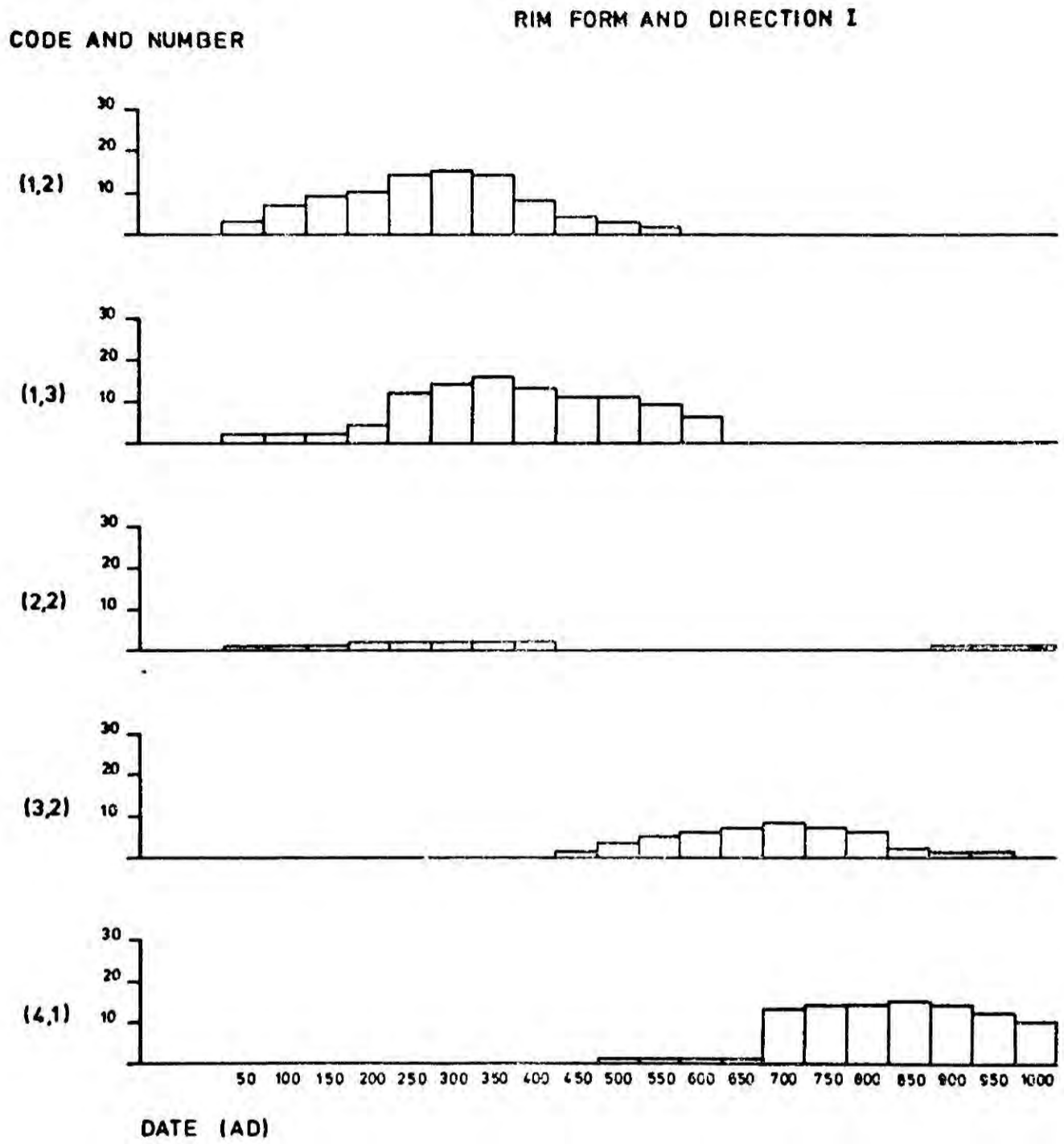
Total dating range AD 150 - 1000. Total number of items used 39.

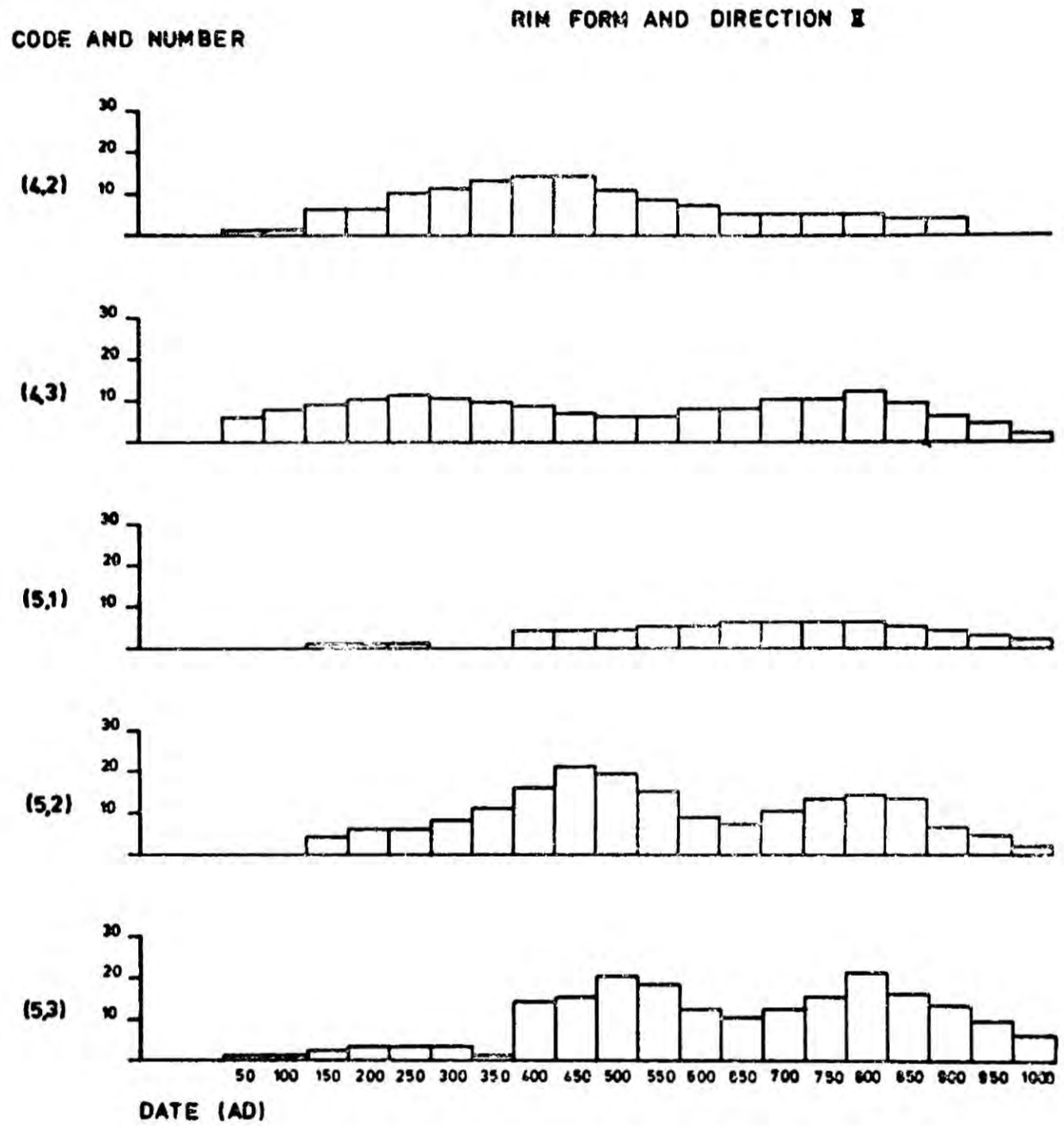
Group C contains those combinations which originated after the fourth century.

<u>Combination</u>	<u>Chronological Span</u>	<u>Total number of items per area</u>	
3,2	ca. AD 400 - 950	Gotland	2 (AD 400 - 700)
		Norway	1 (AD 700 - 1000)
		E. Sweden	7 (AD 700 - 850)
4,1	ca. AD 700 - 1000	Norway	5 (AD 700 - 1000)

Total dating range AD 400 - 1000. Total number of items used 15.

The three groups contain a total of 226 items. Again the west/-east frequency movement is noticeable. Certain "heirloom" items can be perceived in combinations 2,2 and 4,2 in Group A and these clearly exist well beyond the chronological range of the other items in those combinations. Despite these Group A reflects combinations which essentially existed in the earlier part of the millennium although combinations 4,3 and 5,3 contain items which existed up until the year





AD 1000. This is noticeable again in Group B where the traditionally early Norwegian items continued up until the same date. Norwegian items in Group C also continue to the end of the millennium. Again the chronological overlap period between east and west can be broadly associated with the Vendel period.

Other Elements

This column (column G) contains a combination of form and decorative elements which are characteristic or typical of certain well-known vessel types and which because of their comparative rarity are better isolated into a single column. The histogram (fig 29) indicates that they can be divided into three groups (A - C) defined by time of origin.

Group A contains those codes which originated in the earliest part of the millennium.

<u>Code</u>	<u>Chronological Span</u>	<u>Number of items per area</u>	
4 (Handle)	ca. AD 50 - 1000	Bornholm	1 (AD 50 - 400)
		Denmark	1 (AD 150 - 300)
		Norway	2 (AD 400 - 550)
		E. Sweden	1 (AD 800 - 1000)
7 (Stem)	ca. AD 50 - 400	Denmark	2 (AD 50 - 200)
		Norway	1 (AD 300 - 400)

Total dating range AD 50 - 1000. Total number of items used 8.

Group B contains those items which originated in the third century.

<u>Code</u>	<u>Chronological Span</u>	<u>Number of items per area</u>	
2 (Boss)	ca. AD 200 - 600	Denmark	1 (AD 200 - 400)
		Norway	1 (AD 450 - 500)
		Öland	2 (AD 400 - 600)
5 (Inscription)	ca. AD 250 - 1000	Denmark	2 (AD 250 - 400)
		Norway	1 (AD 500)
		E. Sweden	1 (AD 800 - 1000)
6 (Prunt)	ca. AD 300 - 650	Denmark	1 (AD 350 - 450)
		Norway	1 (AD 300 - 400)
		Gotland	1 (AD 550 - 650)

Total dating range AD 200 - 1000. Total number of items used 11.

Group C contains those items which originated after the year AD 500.

<u>Code</u>	<u>Chronological Span</u>	<u>Number of items per area</u>	
3 (Claws)	ca. AD 500 - 1000	Denmark	1 (AD 500 - 600)
		Gotland	3 (AD 550 - 800)
		Norway	3 (AD 650 - 1000)
		E. Sweden	11 (AD 600 - 900)
		Öland	1 (AD 500 - 700)

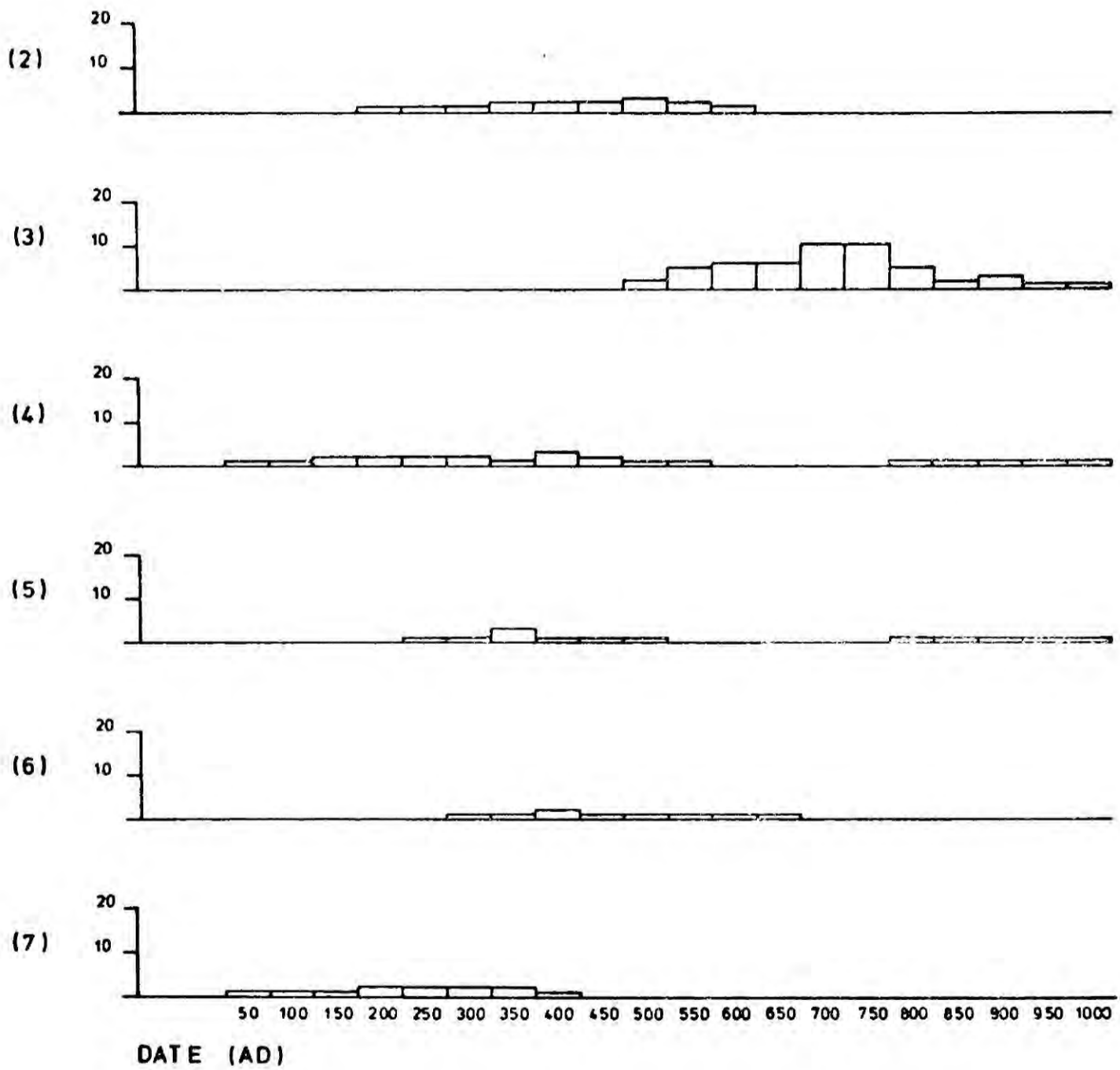
Total dating range AD 500 - 1000. Total number of items used 19.

The three groups contain a total of 38 items. Many of these categories may perhaps be invalid due to the small numbers of items used. Nevertheless they provide an opportunity to list these somewhat

FIG 29.

OTHER FEATURES

CODE AND NUMBER



unusual characteristics. Chronologically the west/east frequency shift is still apparent. However, Group C illustrating the distribution of claw beakers shows a frequency on both sides of Scandinavia in a period approximately coinciding with the Vendel period.

Technique and Form of Decoration

Elements relating to the technique and form of decoration (columns H and J respectively) can be divided into three groups (A - C) defined by the dates of origin of each combination as shown in fig. 30.

Group A contains those combinations which originated in the earliest part of the millennium.

<u>Combination</u>	<u>Chronological Span</u>	<u>Number of items per area</u>
2,3	ca. AD 50 - 1000	Bornholm 8 (AD 50 - 550)
		Denmark 40 (AD 50 - 600)
		Gotland 36 (AD 50 - 800)
		Norway 34 (AD 200 - 1000)
		W. Sweden 20 (AD 200 - 1000)
		E. Sweden 41 (AD 50 - 1000)
		Öland 8 (AD 50 - 550)
4,2	ca. AD 50 - 600	Denmark 16 (AD 50 - 400)
		Gotland 4 (AD 350 - 600)
		W. Sweden 10 (AD 50 - 550)
		E. Sweden 5 (AD 200 - 550)
		Öland 4 (AD 200 - 550)

<u>Combination</u>	<u>Chronological Span</u>	<u>Number of items per area</u>
4,4	ca. AD 50 - 600	Bornholm 1 (AD 200 - 400) Denmark 21 (AD 50 - 500) Gotland 2 (AD 100 - 600) Norway 26 (AD 250 - 500) W. Sweden 10 (AD 50 - 500)

Total dating span AD 50 - 1000. Total number of items used 286.

Group B contains those items which originated around the year AD 300.

<u>Combination</u>	<u>Chronological Span</u>	<u>Number of items per area</u>
4,3	ca. AD 250 - 1000	Denmark 3 (AD 350 - 550) Gotland 2 (AD 250 - 800) Norway 2 (AD 300 - 500) E. Sweden 1 (AD 800 - 1000)

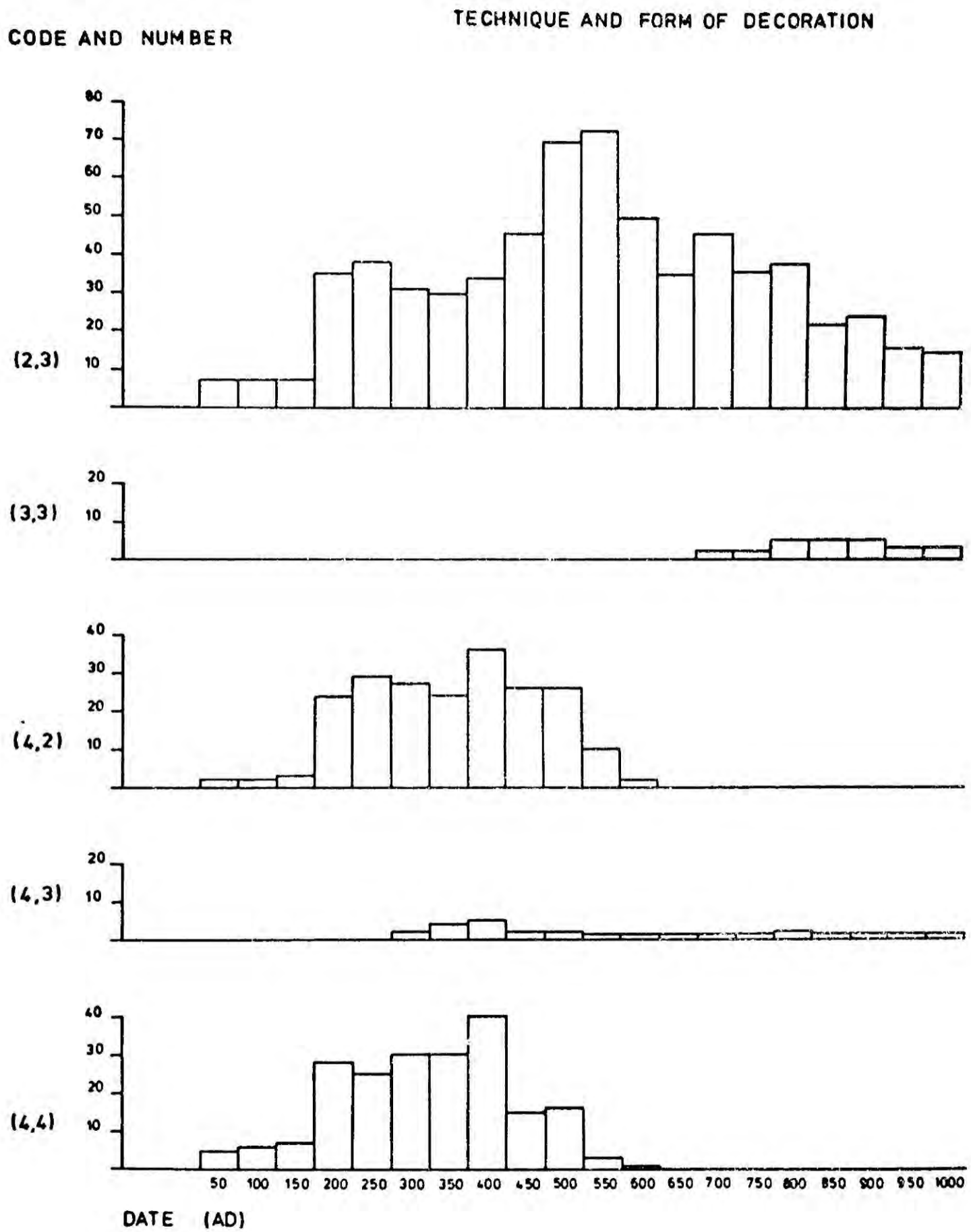
Total dating span AD 250 - 1000. Total number of items used 8.

Group C contains those items which originated after the year AD 700.

<u>Combination</u>	<u>Chronological Span</u>	<u>Number of items per area</u>
3,3	ca. AD 700 - 1000	Norway 6 (AD 700 - 1000) E. Sweden 6 (AD 700 - 1000)

Total dating span AD 700 - 1000. Total number of items used 12.

The three groups contained a total of 306 items, the majority appearing in Group A. Theoretically these decorative elements should reflect any fundamental differences brought about by changes in



place of manufacture, typological progression or trade routes. Decoration itself is the most varied of all attributes of the glass vessel and because of this the chronology and geographical distribution is easier to follow. The two elements combined here (technique and form of decoration) ensure that the manufacturing method and the fundamentals of the decoration are considered together thus providing a more accurate basis for determining variation. The west/east frequency shift is still the most noticeable factor. However, reference to Group A indicates that two combinations (4,2 and 4,4) which failed to survive beyond ca. AD 600 had a distribution throughout Scandinavia. The other two combinations in Group A indicate that finds from the later part of the millennium are not restricted to the Baltic side and that the western finds are not necessarily those from the early part. The picture again suggests an overlap period towards the middle of the millennium. In comparison to the impression given by examining the three main form elements we now have a much clearer view of the extent of this overlap. This is brought about simply by the number of different items used. The form elements were based on 145 items while the decorative elements were based on more than double that figure. This again indicates the advantage of utilising the fragmentary material.

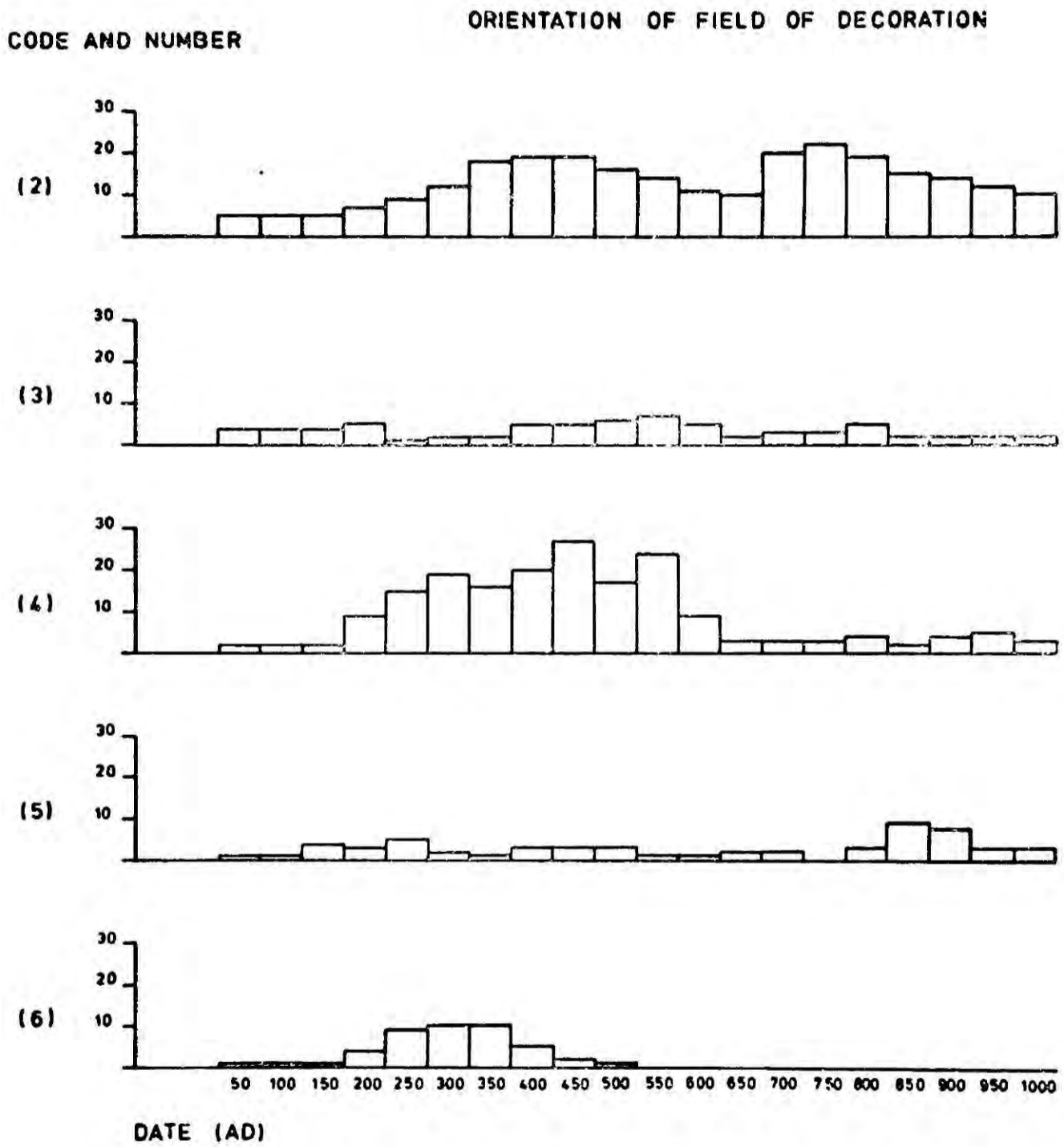
Orientation of Field of Decoration

This column (column I) concludes the discussion on decoration and examines the manner in which the decoration is orientated to the vessel. The histogram (fig 31) indicates that the five divisions can all be

grouped together as Group A and defined by a date of origin in the earliest part of the millennium.

Group A contains those items which originated ca. AD 50.

<u>Code</u>	<u>Chronological Span</u>	<u>Number of items per area</u>	
2,	ca. AD 50 - 1000)	Denmark	8 (AD 50 - 500)
		Gotland	4 (AD 500 - 800)
		Norway	27 (AD 200 - 1000)
		W. Sweden	13 (AD 50 - 1000)
		E. Sweden	15 (AD 400 - 1000)
		Öland	4 (AD 400 - 550)
		3,	ca. AD 50 - 1000
Gotland	4 (AD 400 - 800)		
Norway	3 (AD 50 - 500)		
W. Sweden	1 (AD 400 - 550)		
E. Sweden	6 (AD 500 - 1000)		
Öland	2 (AD 50 - 200)		
4,	ca. AD 50 - 1000		
		Denmark	16 (AD 50 - 550)
		Gotland	11 (AD 350 - 800)
		Norway	26 (AD 200 - 550, 800 - 950)
		W. Sweden	4 (AD 200 - 500)
		E. Sweden	9 (AD 400 - 1000)
		Öland	2 (AD 400 - 550)



<u>Code</u>	<u>Chronological Span</u>	<u>Number of items per area</u>	
5,	ca. AD 50 - 1000	Bornholm	1 (AD 300 - 350)
		Denmark	8 (AD 50 - 400)
		Norway	6 (AD 300 - 700)
		E. Sweden	7 (AD 800 - 1000)
		Öland	2 (AD 400 - 550, 800 - 1000)
6,	ca. AD 50 - 600	Denmark	6 (AD 200 - 500)
		Gotland	2 (AD 50 - 200, 550 - 600)
		Norway	4 (AD 200 - 500)
		W. Sweden	1 (AD 200 - 400)
		E. Sweden	1 (AD 250 - 350)
		Öland	1 (AD 200 - 300)

Total dating range AD 50 - 1000. Total number of items used 199.

In general this column merely emphasised the main frequency shift outlined above. There are some anomalies noticeably the instances where some elements appear well beyond their normal chronological ranges such as in Gotland in code 6, but in general the picture presented is similar to that which has been built above. Perhaps more noticeable from this column is the ubiquity of certain items throughout Scandinavia.

Differentiation of Colour

This final classification deals with the uses of colour (column K) and the relevant histogram can be seen in fig 32. The items can be divided into two groups defined by date of origin.

Group A contains those items which originated in the earliest part of the millennium.

<u>Code</u>	<u>Chronological Span</u>	<u>Number of items per area</u>	
3,	ca. AD 50 - 1000	Bornholm	2 (AD 50 - 400)
		Denmark	16 (AD 100 - 550)
		Gotland	1 (AD 500 - 600)
		Norway	25 (AD 200 - 500, 700 - 1000)
		W. Sweden	3 (AD 200 - 400, 600 - 1000)
		E. Sweden	14 (AD 50 - 350, 600 - 1000)
		Öland	5 (AD 400 - 650, 800 - 1000)
5,	ca. AD 50 - 1000	Denmark	5 (AD 50 - 400)
		Norway	4 (AD 50 - 200, 700 - 1000)
		E. Sweden	6 (AD 800 - 1000)

Total dating range AD 50 - 1000. Total number of items used 81.

Group B contains those items which originated in the second century.

<u>Code</u>	<u>Chronological Span</u>	<u>Number of items per area</u>	
6,	ca. AD 200 - 550	Gotland	2 (AD 200 - 500)
		Norway	7 (AD 200 - 550)
		W. Sweden	2 (AD 400 - 550)
		E. Sweden	2 (AD 400 - 500)

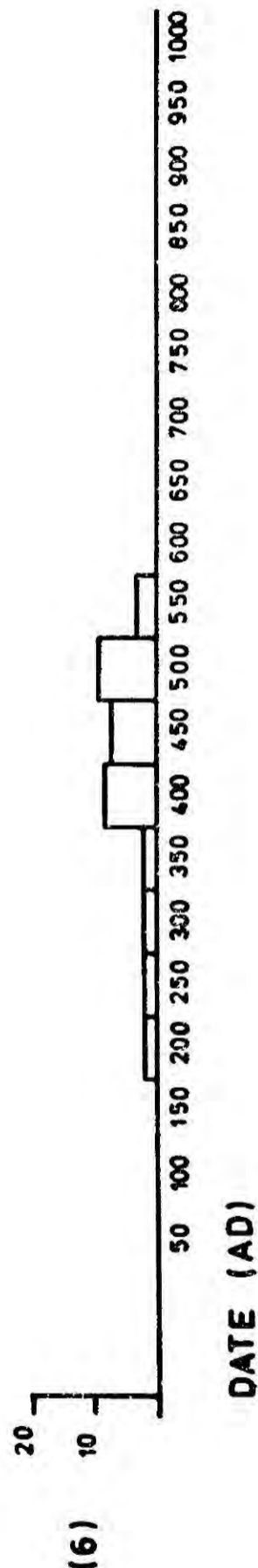
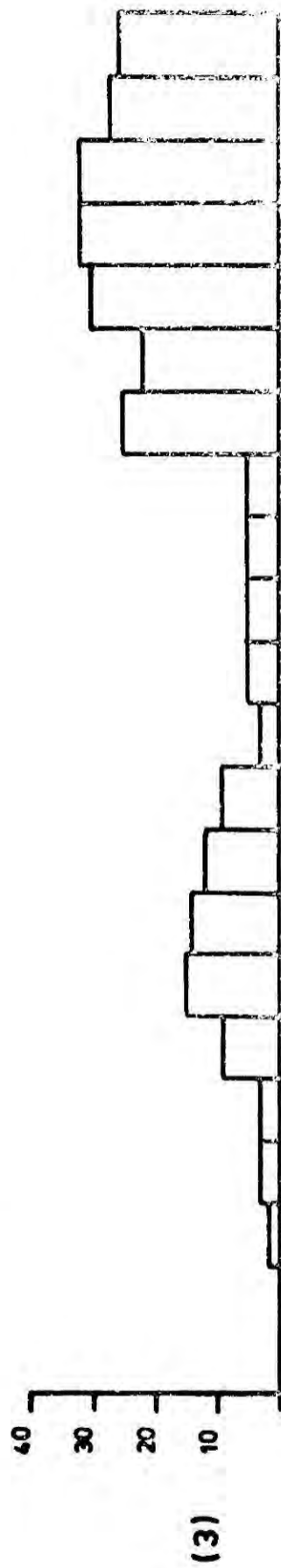
Total dating range AD 200 - 550. Total number of items used 13.

The analysis of colour differentiation used 94 different items.

Group A indicates that the use of bichrome decoration persisted

DIFFERENTIATION OF COLOUR

CODE AND NUMBER



DATE (AD)

throughout Scandinavia noticeably in Norway and Sweden (excluding Uppland and Södermanland) until the end of the millennium. In general Group A reflects the overall picture of the west/east frequency shift. Group B is slightly different. Here code 6 represents the überfang (cased) vessels which disappeared in the sixth century. Their appearance on two occasions on the Baltic side in this early period may be significant.

The overall impression of this analysis is that the frequency shift is not as simple as it initially appeared. Throughout nearly all the codes and combinations discussed the shift is certainly apparent although the cause itself needs defining. This type of analysis assumes from the outset that the various codes and combinations are valid defining criteria, in other words that these groupings actually represent typological components of vessels which were recognised at the time of manufacture. The first combination which contains the three basic shape elements must essentially be an "a priori" aspect as I argued earlier in relation to function (chapter 4). In the main the other codes and combinations do not reflect function, but rather appear under the over-simplified heading of "style". These will be the product of the glass-master's imagination and tradition. Their geographical distribution will be governed by the location of the glasshouse and the extent of accessible trade. For the most part the chronological life of particular elements is contained within a framework of continually altering typologies and follows a path of development or degeneration. The factors to be examined in this

analysis are therefore those which appear as anomalies to the main west/east frequency shift, particularly in the overlap period, and the presence of similar typologies on both sides of Scandinavia.

The first elements analysed showed that the combination of form, proportion and profile could be grouped in terms of their dates of origin. They indicate that batches of different vessel types appeared at four clearly defined times in the millennium. This itself is significant. Furthermore, if one examines the typologies of these batches it can be seen that each separate influx does not represent a mere typological development from the last but contains vessels which in most respects are different from those of other influxes and which represent an almost total replacement of the existing types. Group A shows that the very first influx of vessels (ca. AD 50) all appeared in Denmark, Norway and W. Sweden with some examples appearing later on the eastern coasts. This suggests that the trade or manufacturing impetus was via the west of Scandinavia and that a period of time (as much as 300 years) was required for transmission to the east coast. The conclusion must be that the Baltic coast areas can have had no direct contact with the contemporary glass manufacturing centres. A similar time lag occurred for the transmission of the material to Norway. In this earliest period Denmark played a leading role as a place of import. European distribution outside Scandinavia shows that Scandinavia was the northern extreme in the distribution of glass in this period ⁽⁶⁾. Typologically all these examples are paralleled elsewhere and have their origins in the glass

houses of the Mediterranean, particularly in the Middle East.

This has been clearly demonstrated by Ekholm and others and there is little point in repeating it here (7).

The typological changes represented by the second influx of glass into Scandinavia in the third century seem in the most part to have been caused by the establishing of glass houses on the Continent, particularly in the areas bordering the Rhine. Increased production from these centres together with their geographical proximity must be the major causes for the increase in number of items as indicated by the frequency distribution. At this period of time it seems that variation in burial tradition was not instrumental in the nature of this influx.

By the time these new forms were arising in the west the wave effect of the earlier items was still being felt in the more extreme areas, and apart from the occasional "heirloom" object they had vanished by the end of the fifth century. It is conceivable that these items were local copies rather than genuine eastern imports and this possibility will be taken up later with regard to decorative qualities. The time lag of some three hundred years between the early finds in the west and the east can hardly be explained by reasons of travel and slow trade.

The second spate of vessels (Group B) in the third century had a more even geographical start in the west and was almost totally confined to that area. Only two items out of the 41 recorded appeared on the Baltic side and only in Gotland did the finds persist until the end of

the fifth century. The initial Danish distribution again suggests that Denmark was the Scandinavian point of entry for the North Sea trade route from the Rhineland. There is no evidence of residual types as in the first influx, but by the year ca. AD 400 and conceivably even before that time the Mälaren trading centre of Helgö in E. Sweden was already in operation. Of the 69 culture layer fragments from Helgö included in the catalogue several belong to forms which are similar to those in the west. The unstratified deposits are difficult to evaluate but it would seem likely that glass types were appearing in Helgö at a time when similar types were present in Denmark. There is little evidence of these types on the rest of the Baltic side.

The third influx of vessel forms appears in the west in the fifth century presumably at a time when the Roman glass houses were taken over by the Germanic peoples. This influx ceased by ca. AD 550. These types reached the east coast sites some 100 years after their arrival in the west, and the recorded examples in Group C show an equal distribution in both east and west. The latest examples which appeared in E. Sweden had vanished by ca. AD 800. The small number of complete items reflects the prevalence of the cremation burial at that time but the lower overall number of items throughout this period must reflect a lower volume of output. One can perhaps assume for the time being that these were still the products of the Rhineland. However, once again the change in overall glass vessel form is a fundamental one and does not simply reflect a process of typological development

from the previous phase. Again Helgö has to be considered. There are a number of fragments here which are typologically similar to those in the rest of Scandinavia and which will be discussed below in terms of their decorative qualities.

The final influx of vessels commenced ca. AD 650 and reached a climax some 150 years later at the advent of the Viking period. The distribution of complete items was centred mainly around Uppland and Södermanland with one example in Norway and one in Gotland. The distribution has now changed completely since the earliest years of glass in Scandinavia. Some of these forms have eastern affinities and can be associated with an eastern trade route known to have existed through the Malaren valley. Other examples, noticeably the funnel beaker, appear on the continent. Several of the Uppland and Södermanland vessels have decorative features whose main distribution is inside rather than outside Scandinavia and this suggests that a local place of manufacture may have existed. Helgö again must be considered. Although the site is said to have effectively been replaced by Birka in ca. AD 800 fragments of vessel forms which appear there are from the same forms which existed in the rest of Uppland and Södermanland (including Birka) after that time. This would suggest that activity on Helgö persisted well into the Viking period. As a point of entry for import trade Helgö was ideally situated and the finds from the site reflect a wide ranging commercial contact. Helgö as a manufacturing centre must also be considered. Metal working is known to have existed on a large scale and so we may be justified

in assuming that some form of distribution network existed (8). There is no reason why the same could not equally well apply to glass. In terms of the distribution of all glass in Scandinavia Helgö alone yielded fragments in some quantity from after ca. AD 400 and the presence of glass working on the site is one solution which would explain the curious west/east shift. If indeed glass working did take place one could produce the following hypothesis, namely that the early Scandinavian glass on the west coast from the third to the fifth century consisted mainly of products of the Rhineland after which time Helgö flourished and the distribution shifted to the east. An overlap period, probably between ca. AD 600 - 750 has already been noticed in the above analysis.

The next stage is to consider the other codes and combinations in the light of this initial analysis. The base elements show the presence of six variables. Group A and Group C contain the only two clear codes associated with the influx theory above. Here Group A represents vessels with ribbed feet and with foot rings and Group C vessels with a mouthpiece (i.e. drinking horns). They existed between ca. AD 50 - 400 and ca. AD 200 - 550 respectively. Both are restricted to the western side of Scandinavia. Group B contains three codes which span the millennium. Code 1 representing the flat base appeared first in Denmark, Norway, W. Sweden and Öland. By ca. AD 550 they ceased to exist in all but Norway. Examples from Gotland and E. Sweden appeared from ca. AD 500 at a time when Helgo was fully active. If one examines the Norwegian examples after ca. AD 550 the

typological affinities seem to belong to the east rather than to the west of Scandinavia. Using the base elements here in association with other elements it appears that some of the later Norwegian finds are of east Scandinavian origin rather than of west. These Norwegian examples seem not to be the product of trade via Denmark. The examples of code 1 (flat bases) at this time in Norway are those from Hopperstad (334 and 335) and from Løland (400). According to Bruce-Mitford the last example may have been imported from England, but the first two are represented by a squat jar whose filigree decoration has a major distribution in Uppland and Södermanland and a small flask without any western parallels.

Code 2 relating to the presence of a foot might be expected to have a fairly general distribution being a particularly common form of vessel base. However, much the same picture emerges. The earliest distribution is in Denmark and W. Sweden with a further impetus in ca. AD 200 in Bornholm, Norway and Öland. This reflects a picture already established using the form elements. By ca. AD 550 there are no western examples. In the east no examples were found in Gotland dated to before AD 400 and none in the Uppland and Södermanland regions before ca. AD 650. Five of the Gotland examples belong to vessels of the "Snartemo" type the distribution of which is confined almost entirely to Gotland and Norway. Once again Norway is shown to have a distinctly E. Scandinavian connection.

The rounded base (code 6) shows a similar picture to that of the foot. The same geographical shift is indicated with a slight overlap

period with the Norwegian examples continuing to the end of the millennium. By this time the eastern examples are almost totally represented by funnel beakers. Although only one of these (420, Sanddal) appears in a Norwegian burial several fragments appear at Kaupang. These again indicate a link between the Baltic and Norway towards the end of the millennium.

The rim element combinations fit into the established picture. Group A shows combinations dating from ca. AD 50 and indicates that western Scandinavia, especially Denmark yielded the earliest items with the distribution moving chronologically via Norway to the east coasts. There are some exceptions, but this overall movement is generally maintained. An interesting point is that only four of the six combinations appeared in Gotland and only two in the Uppland and Södermanland regions. These four (1,3, 4,2, 4,3 and 5,3) all occur in the fifth century at a time when their counterparts in the west were reaching the end of their days. The final two combinations were present in the Uppland and Södermanland regions shortly after and represent vessels with rounded straight rims (4,3) and rounded and thickened straight rims (5,3). The Gotlandic types include both these together with cut broken straight rims (1,3) and rounded out-turned rims (4,2). It seems odd that Gotland should have exhibited types not found in the Mälaren regions, but examination of the Helgö fragments shows that combination 4,2 existed there (i.e. 551, 567, 581). The Norwegian connection is still apparent with eight examples of 4,3 appearing after ca. AD 400. This compares well with the Mälaren total

of seven. There are however no examples of 5,3 in Norway in comparison to the E. Sweden total of eighteen.

The two Group B combinations commenced in the second century with the combination representing rounded, thickened and in-turned rims (5,1) appearing only in Denmark in ca. AD 150 and the Uppland and Södermanland regions some 500 years later. The single Danish example seems suspect especially considering the time lag involved. The other combination, which represents rounded, thickened and out-turned rims (5,2) also commenced ca. AD 150 in Denmark and moved chronologically via Norway and Öland to Gotland and W. Sweden in ca. AD 400 and to the Mälaren regions some 250 years later. The last half of the millennium sees only one item of this combination from Gotland, three from Norway and seven from the Uppland and Södermanland regions.

Group C contains perhaps the most significant combination here and represents the folded out-turned rim (3,2). Nine of the ten recorded examples lie in the eastern regions, the single exception being in Norway. Chronologically the earliest examples are from Gotland. The number of these rim forms can be increased by including six fragments from the Helgö material (556, 566, 578, 535, 597 and 613) thus giving a strong distribution field in the east. The other code contains the rounded and in-turned rims (4,1) and shows a distribution confined to Kaupang in Norway between ca. AD 700 - 1000. From the eastern side only Helgö produced a parallel (577).

Once again, although the general impression of the rim elements indicates a complete changeover of types, it also shows that several different types from west and east overlapped in the middle of the millennium. There are examples of types which existed solely in the east or solely in the west at the extremes of the millennium, but it is this overlap period roughly coinciding with the Vendel period which tends to suggest that two different centres of output were responsible for the variation.

The "other" features represented by column 8 relate to particular idiosyncracies which appear throughout the period. Only two of these, code 4 (handle) and code 7 (stem), appeared early in the millenium. The chronological distribution is essentially an early one and represents vessels of Roman origin of well-attested type and known European distribution. The exception is the handle from E. Sweden (662, Järfälla) from a vessel imported from east of the Mediterranean in the Viking period. The number of items is too small to draw any valid conclusions. Group B contains items which originated in the third century and which have a similar distribution. Here bosses, inscriptions and prunts comprise the 11 examples. Again the distribution is western with the three latest types appearing in Gotland and Öland until ca. AD 600. The exception is the fragment from an E. Swedish vessel (661, Järfälla) with an eastern inscription in Coptic lettering. The earlier inscriptions are all classical.

The final group consists of code 3 representing the presence of claws, and these only appear after ca. AD 500. Of the 16 represented

the earliest are the single example from Denmark (033, Dankirke). The remaining distribution has 11 examples in the Uppland and Södermanland regions and 3 in Norway. If one includes the fragments of claws from Helgö, the east Scandinavian items total 20. Although many of the examples are exceedingly fragmentary an interesting fact emerges. Traditionally the claw beaker has an accepted typological development outlined by Harden among others, in which the vessel progresses to a narrower and taller version with the claws less pronounced and flatter ⁽⁹⁾. The Anglo-Saxon examples are considered to represent the early stages of this development with the Taplow beaker being cited as one of the more developed examples from the sixth century. If one accepts this conventional typological development one must assume that the Mälaren examples by both date and typology are at an even more developed stage than the Taplow beaker. Certain evidence conflicts with this. The earliest Swedish examples can be dated to the seventh century such as the vessels from Vendel (744, 747 and 748) and all have elongated flattened claws. There is no real comparison between these and the latest Anglo-Saxon example from Sarre, Kent which shows a bag-shaped vessel without foot and almost cylindrical in form. On the Continent there are no parallels to these Swedish examples. Even in the rest of Scandinavia all the fragments of useful size are divided between these two groups. The Norwegian example from Borre (305) which is considered to have been an "heirloom" object from a burial context dated to the end of the ninth century is typologically Anglo-Saxon rather than Swedish. The body is squat and the claws large and hollow. Both the

sufficiently large Gotlandic fragments (217, Grötlingbo and 281, Roma) can be paralleled in Uppland and Södermanland and not in England or the Continent. It would appear that the claw beaker types found in the east Scandinavian areas are unique and one can only assume that they were the products of a local industry. In terms of quality they were clearly inferior vessels. The bright colours of the earlier Anglo-Saxon and Germanic examples are not apparent and there are numerous flaws in the form of streaking and bubbles. The vessel form itself is often uneven, the claws badly applied and not hollow and the foot incapable of supporting the body. They may indeed be copies and if we place their origins somewhere in the seventh century we can suppose that they were modelled on English or Continental examples at a stage of development represented by the Taplow beaker.

The decorative elements used in combination (technique and form of decoration) show an interesting distribution both geographically and chronologically. Group A which contains three combinations originating ca. AD 50 can be divided, two combinations ending ca. AD 600 and the other lasting the millennium. The former contains the combinations 4,2 and 4,4 representing ground or incised decoration with the first using faceted shapes and the second with both faceted and linear shapes. In each case Denmark and W. Sweden yielded the earliest items. By the year ca. AD 400 both combinations were apparent throughout most parts of Scandinavia. In all 99 different items were represented. The most interesting part of the distribution, however, is that 11 of these appeared before AD 600 in E. Scandinavia and that

no less than 26 were found in Norway. Clearly this conflicts with the distribution of the complete items, and shows that by using the fragmentary material in this way a slightly different picture can be formed. These figures can be supplemented by an additional 4 (600, 601, 608 and 609) from Helgö giving an eastern total of 15. Their dating range (excluding Helgö) of ca. AD 100 - 600 is one which does not confirm the results of this analysis at this stage.

The other combination (2,3) representing applied decoration of a linear form shows a similar discrepancy. Here the year ca. AD 50 sees a distribution throughout Scandinavia apart from Norway and the west of Sweden where the first examples only appear after ca. AD 200. The total of 187 examples indicates this to be by far the most popular decorative form discovered. The very nature of this popularity may render the analysis of this form futile with its appearance being noted on such a large scale. However, two factors point towards its importance. First of all it shows that the items from the later part of the millennium are not totally confined to the east coast, and secondly that the earlier items are not totally restricted to the west coast. It should also be pointed out that no less than 27 examples can be added from Helgö.

Group B contains the combination 4,3 which represents items with ground or incised decoration formed in a linear manner. This mostly consists of vessels with simple horizontal incised lines below the rim. The distribution seems to occur with the start of the second influx of vessel forms in the third century. Denmark, Gotland, Norway

and W. Sweden all have examples in the first half of the millennium. The only two items dated to beyond this time are from Gotland (288, Stånga) and E. Sweden (487, Birka). The former is from a burial the date of which is disputed and the latter from a very fragmentary vessel discovered in a Viking burial. The 8 examples from this combination are essentially too few to be of real value.

Group C on the other hand only contains 12 items yet when considered in a European context is of great significance. The combination represented (3,3) is that of filigree decoration formed in a linear manner. A full discussion of this type of decoration is set out in Appendix 2, but the main points are worth recounting here. The approximate earliest date of origin is ca. AD 700 which coincides with the final vessel type influx in the east. More important, however, is that the distribution is confined to Norway and the Uppland and Södermanland regions. If the Helgö fragments are included the total reaches 22. On a broader front the European distribution contains only a handful of examples from the later Anglo-Saxon sites together with a single continental example. The main density of fragments lies in Scandinavia and again one must be prepared to consider the possibility that filigree vessels were a Scandinavian rather than continental product.

The remaining decorative categories relating to the orientation of field of decoration can all be grouped together with the same date of origin (ca. AD 50). Of the five codes four span the millennium and the fifth (code 6) ends at the close of the sixth century. The

former codes (codes 2,3,4 and 5) show great discrepancy in their chronological and geographical distribution. Code 2 (horizontally orientated) has by the end of the third century a distribution in Denmark, Norway and W. Sweden, code 3 (vertically orientated) in Denmark, Norway and Öland, code 4 (both horizontal and vertical) in Bornholm, Denmark, Norway and W. Sweden and code 5 (other) throughout Scandinavia with the exception of Bornholm. In other words by ca. AD 200 the western distribution coincides geographically with the first influx of vessels. After this time the movement shifted predictably to Gotland, Norway and E. Sweden. The very latest examples appear in Norway and Sweden with the majority in Kaupang and the Mälaren valley sites. The distribution of all four is very similar. The use of horizontal and vertical decoration clearly reflects basic methods of simple decoration. There seems to be no significant difference between them, or for that matter between them and a combination (code 4) containing them both. Chronologically and geographically they are indistinct. Their dates and distribution tend to follow the main west/east frequency shift and reflect the different vessel influxes into Scandinavia.

Code 5 contains an assemblage of "other" orientations of decoration. In the most part these represent vessels whose bodies are almost totally covered with decorative bands or friezes. The Danish examples include vessels with painted scenes where the decoration fills the outer face of the body. These vessel types are fully discussed in Appendix I. The Norwegian examples include a

bowl from Falkum (315) with marvered combing and a jar from Løland (400) showing a form of criss-cross decoration. The examples from the Uppland and Södermanland regions include several fragments from funnel beakers showing arcaded trails (507 and 511, Birka). One fragment (506, Birka) shows a tree of life depiction. In general the numbers are too small to be of value. They represent methods of decoration which cannot fit into any of the other codes. Their rarity tends to single them out as special items. Only in the case of the painted classes from Denmark is a particular group noticeable.

The final code (Code 6) represents items with horizontal or vertical decoration in combination with other elements not already recorded. Two clear groups emerge. The first contains vessels with applied "snake" or zig-zag decoration which appear mostly in Denmark (143, Nordrup and 150 Rislev). Their appearance coincides with the second influx of vessels around ca. AD 200. The second group contains examples of ground or incised decoration formed in Y-shapes (317, Foldvik and 456, Øvre Moer). These are essentially Norwegian in distribution with a single example from Sweden (732, Tanum). These too can be associated with the second influx of vessels.

The final part of the analysis deals with differentiation of colour. Two groups can be determined. Group A contains items which span the millennium and includes two codes, codes 3 and 5, the former representing vessels with coloured decoration and the latter

representing vessels whose main body contains more than a single colour. Essentially this analysis retraces information already gathered and divides the material into known groups. The painted animal cups and vessels with coloured trails (many of which are "snake" trails) both constitute a large part of the earlier material in code 3. There is, however, a clear break in the use of coloured decoration in the seventh century. After this time examples only appear in Norway, Sweden and Öland, and these types are totally different to the earlier western types. There are two main groups in this later material, one containing vessels with filigree decoration and one containing horizontally applied coloured trails. The latter are usually associated with the claw beaker type of vessel. Both groups have been discussed above. It only remains to say that this colour analysis has provided another method of isolating the two vessel groups thus emphasising their importance. Helgö yielded a further 14 fragments in this category. Code 5 contains only a few examples of vessels exhibiting more than one colour. The early examples are mostly Danish and represent the pillar-moulded bowl of the Espe type (038) although the very earliest, and possibly the very first vessel to appear in Scandinavia, is the cameo vase from Norway (426, Solberg). Both were presumably part of the earliest influx after ca. AD 50. Again there is a complete split in the chronological distribution. The later types from Kaupang and the Uppland and Södermanland regions, apart from containing the occasional vessel of obvious eastern import (515,

Birka), offer a collection of vessels usually of the funnel beaker type with a coloured rim. Examples of these appear in the Birka gravefield (486) and in Norrsunda (693). Additional examples were found at Helgö. Once again a clear distinction emerges in the distribution.

Group B contains only one code (code 6) representing the *uberfang* or "cased" vessel whose dating ranges cover the period between ca. AD 200 - 550. The earliest examples appear in Gotland and Norway while the Swedish finds only appear after ca. AD 400. There is little doubt that the first examples are the product of the earlier influxes of vessels into Scandinavia and although their technique is in essence east Mediterranean, they are conceivably the work of the Rhineland houses using the skills of glass workers who had migrated from the east. The later examples are less easy to pin down. It has often been maintained that these were degenerate items fashioned by the craftsmen who continued in the Rhineland after the Roman withdrawal beyond the fourth century. Items such as the Norwegian example from Tu (442) dated to around ca. AD 500 shows that at least by that time the high quality was still very much apparent. Another Norwegian example from Enebø (314) shows a less satisfactory version of poorer quality. The majority of these items are fragmentary and little can be said regarding their quality. Their presence in such princely contexts as the Uppsala mounds (623) gives them a certain status above other vessels, and their rich colouring surely gave them an added prestige value. No examples appear at Helgö. If indeed the later versions are no more than local copies then this absence is difficult to explain.

CHAPTER SIX - REFERENCES AND NOTES

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CHAPTER SEVEN - THE ANALYSIS OF MAJOR ELEMENTS

With reference to the factors outlined in chapter 4 the analysis of elements which constitute glasses of varying ages can supply the archaeologist with additional forms of information. This information includes both regional and chronological variation of glass types defined by means of differences in natural raw material together with information regarding the developing technology of glass manufacture defined by chronological variations in the use of specific chemical ingredients. Against this potential information there are two possible drawbacks. The first concerns the presence of accidental impurity and the second relates to the re-use of existing glass material or to a trade in broken glass for the production of glass frit. Both could severely hamper any attempt to classify vessels in terms of their elements. A difficulty arises in determining the extent to which a discrepancy between the quantities of a particular element in two different vessels represents a difference in raw material or signifies the deliberate use of an additive. This problem will be examined later.

The use of the major elements which constitute glass has always seemed of limited value. Changes in the major elements can only produce substantially different types of glass. In early history these changes are limited to broad chronological periods which are of little help in the classification of vessels or fragments to within less than a millenium. The changes here are so fundamental that the glasses can often be classified by means of visual examination. The composition of mediaeval glasses differs from more modern glasses in having significantly higher

lime and magnesium contents and a lower silica content (1). The most fundamental change with regard to earlier glass concerns the change from soda-lime glass to 'weald' or 'forest' glass, the latter being considerably higher in potash content traditionally derived from bracken. In western Europe this change occurred as early as the tenth century and the subsequent glasses, often of a dark brown or green colour have a noticeable tendency towards a type of weathering which consists of crusts on the surface (2). Thus before this change, in an era when glass produced in Europe was almost entirely of the soda-lime variety, the differences between the major elements in the few analyses undertaken seemed so small that no clear regional or chronological distinctions could be ascertained. In many cases the purpose of analyses were primarily to certify that the glasses under study were soda-lime and not of the 'weald' variety.

Scandinavian glass has only been examined briefly by analysis. It has always been maintained that pre-mediaeval Scandinavian glass was imported from the continent and supplied by the same glass-houses which provided the majority of wares in France, Germany and Britain. Throughout western Europe most of this glass appears from pagan burials and is therefore essentially limited to the pre-Christian era. Only in Scandinavia where Christianity was considerably later in arriving did pagan burials persist for almost a further four hundred years. Consequently the glasses from Scandinavia from this period (approximately the Vendel and Viking Periods) may be representative of glasswares in the rest of Europe where the earlier advent of Christianity removed them from burials.

Only two attempts at analysis have been made on Scandinavian material. Arwidsson touched upon the subject in a discussion concerning the availability and relative proportions of the oxides of lead and copper in the vessels from Valsgärde, Sweden (3). The investigation of colouring oxides, however, was the main purpose of the study. Fuller analyses for comparative purposes were carried out by Arbman using nine samples from the Vendel and Viking Periods (4). These were tabulated against eight samples from the continent ranging from the fourth to the fourteenth centuries. The subjects were chronologically and geographically too distinct for the proportional chemical differences to be of value. The main conclusion reached was that the variation was significantly large to merit further investigation. Since the publication in 1937 no further analyses were carried out.

Several works from England and the continent have supplemented this information by providing useful tables of comparative material. Many are of similar date to the Scandinavian period under discussion. Of particular interest are the analyses of glass vessels from the Merovingian Period conserved at Namur, Belgium (5). Although the colouring elements were again the main purpose of the work full analyses are tabulated for a group of glasses roughly corresponding with the Vendel and Viking Periods. Similarly the window glass from Jarrow and Wearmouth, England provide a useful comparative corpus of results from a context which allows dating between the end of the seventh and the ninth centuries (6). Chambon and Arbman in their discussion concerning the problems of continuity in glass working in Belgium also produced a small table of results (7). Included here

are four samples from Scandinavia.

The mediaeval period glasses have been studied to a somewhat greater degree. The Corning Museum in the U.S.A. has probably played a leading role in glass analysis of the mediaeval period in Europe both in the analysis of stained glass from windows and in the discussion of early technology (9).

At this point some mention should be made concerning the selection of the Scandinavian samples analysed here. Ideally the samples should satisfy three needs. They should represent a large proportion of the glass available in order that the conclusions are statistically credible. They should also derive from both complete and incomplete vessels so that any results may be related to typological change. Finally, the samples should be fully representative both of the chronological period in question and of the geographical distribution of the vessels. These are ideal criteria for selection, but unfortunately not practical criteria. As far as the first point is concerned it must be remembered that museums and institutions are often reluctant to part with samples of their material for a new and destructive process, especially one carried out in a different country. In this respect I was fortunate and grateful for the assistance offered by the State Historical Museum, Stockholm and by the Visby Fornsal, Gotland in allowing me access to their fragmentary material. The total number of samples taken was ninety-five, this being slightly over ten per cent of the total material available. No samples were taken from complete vessels. However, certain fragments were from clearly defined types of vessel and consequently

a potential relationship to typological change was not ruled out. The majority of these fragments lay in a datable context, although the date concerned relates to the date of the burial and not necessarily to the approximate time of manufacture of the vessel. It was possible to select samples from the early Roman Iron Age to the Viking Period. The Roman Iron Age provided fewer fragmentary samples than one would have liked, the majority of glass from that period being complete. However, a large number of samples were taken from the overlap phase at the beginning of the Migration Period and this may compensate. The Migration and Vendel Periods are both well represented. In the Viking Period when glass tends to be less common in Scandinavia the number of samples was not all that might be desired. Nevertheless sufficient samples were gathered from all periods to provide a working comparison. Many of these samples are dated to the end of one period or the beginning of the next. In these instances I have always placed the sample in the earlier period thus allowing for use and time taken for any importation. The chronological periods are used here only to indicate broadly the range of the sampling. Also included were a proportion of undated samples in order to see if classification was possible within a framework established by the dated samples. The number of samples are as follows:

<u>Chronological Period</u>		<u>No. of Samples</u>
Roman Iron Age	-	9
Migration Period	-	30

<u>Chronological Period</u>		<u>No. of Samples</u>
Vendel Period	-	34
Viking Period	-	14
Undated	-	<u>8</u>
		<u>95</u>

It was also hoped to obtain a geographical cross-section of samples to try and denote regional as well as chronological distinctions. This was less simple. The majority of burials containing glass tended to occur in the comparatively wealthy regions of Gotland, Uppland and Södermanland. Other samples were taken from elsewhere, but these were in a clear minority. Despite this the sampling shows a good geographical spread in that it relates in the most part to the areas in which glass was most common. A breakdown of the geographical sampling is as follows:

<u>Region</u>		<u>No. of Samples</u>
Gotland	-	39
Uppland	-	28
Södermanland	-	10
Medelpad	-	9
Östergötland	-	2
Dalsland	-	1
Halland	-	1
Närke	-	1
Småland	-	1

<u>Region</u>		<u>No. of Samples</u>
Västergötland	-	1
Västmanland	-	1
Öland	-	<u>1</u>
		<u>95</u>

The complete list of samples given below gives the sample number for analysis, the catalogue number and the general date of the sample together with the Swedish province in which it was found.

No comment is made upon colour.

<u>Sample</u>	<u>Catalogue No.</u>	<u>Chronological Period</u>	<u>Location</u>
1	498	Viking	Uppland
2	501	Viking	Uppland
3	509	Viking	Uppland
4	521	Viking	Uppland
5	526	Viking	Uppland
6	531	Viking	Uppland
7	532	Viking	Uppland
8	535	Viking	Uppland
9	543	Roman	Dalsland
10	191	Vendel	Gotland
11	193	Migration	Gotland
12	197	Vendel	Gotland
13	198	Vendel	Gotland
14	201	Undated	Gotland
15	215	Undated	Gotland

<u>Sample</u>	<u>Catalogue No.</u>	<u>Chronological Period</u>	<u>Location</u>
16	218	Migration	Gotland
17	219	Roman	Gotland
18	220	Migration	Gotland
19	222	Migration	Gotland
20	224	Migration	Gotland
21	226	Migration	Gotland
22	227	Migration	Gotland
23	254	Migration	Gotland
24	262	Vendel	Gotland
25	271	Migration	Gotland
26	273	Migration	Gotland
27	286	Vendel	Gotland
28	287	Vendel	Gotland
29	289	Vendel	Gotland
30	290	Vendel	Gotland
31	292	Vendel	Gotland
32	293	Vendel	Gotland
33	639	Roman	Halland
34	462	Migration	Medelpad
35	463	Migration	Medelpad
36	683	Undated	Medelpad
37	685	Migration	Medelpad
38	686	Migration	Medelpad
39	705	Migration	Medelpad
40	706	Migration	Medelpad
41	707	Migration	Medelpad

<u>Sample No.</u>	<u>Catalogue No.</u>	<u>Chronological Period</u>	<u>Location</u>
42	708	Migration	Medelpad
43	720	Vendel	Närke
44	476	Vendel	Södermanland
45	646	Vendel	Södermanland
46	647	Vendel	Södermanland
47	650	Vendel	Södermanland
48	649	Vendel	Södermanland
49	668	Undated	Södermanland
50	718	Vendel	Södermanland
51	716	Vendel	Södermanland
52	717	Vendel	Södermanland
53	638	Viking	Småland
54	461	Viking	Uppland
55	540	Vendel	Uppland
56	541	Viking	Uppland
57	542	Viking	Uppland
58	624	Migration	Uppland
59	623	Migration	Uppland
60	653	Vendel	Uppland
61	654	Vendel	Uppland
62	660	Migration	Uppland
63	666	Viking	Uppland
64	703	Roman	Uppland
65	714	Vendel	Uppland
66	726	Roman	Uppland
67	727	Roman	Uppland

<u>Sample No.</u>	<u>Catalogue No.</u>	<u>Chronological Period</u>	<u>Location</u>
68	725	Roman	Uppland
69	731	Vendel	Uppland
70	749	Migration	Uppland
71	743	Vendel	Uppland
72	756	Viking	Uppland
73	760	Undated	Uppland
74	644	Vendel	Västergotland
75	471	Roman	Västmanland
76	804	Undated	Öland
77	641	Undated	Östergotland
78	671	Vendel	Östergotland
79	648	Vendel	Södermanland
80	232	Migration	Gotland
81	233	Migration	Gotland
82	234	Migration	Gotland
83	235	Migration	Gotland
84	236	Migration	Gotland
85	238	Migration	Gotland
86	240	Migration	Gotland
87	242	Undated	Gotland
88	243	Vendel	Gotland
89	245	Vendel	Gotland
90	247	Vendel	Gotland
91	248	Vendel	Gotland
92	449	Roman	Gotland

<u>Sample No.</u>	<u>Catalogue No.</u>	<u>Chronological Period</u>	<u>Location</u>
93	250	Vendel	Gotland
94	251	Vendel	Gotland
95	252	Migration	Gotland

The number of different oxides which appear in early glasses can present a confusing picture since many of these oxides are inadvertently present through impurity in the natural material. They are useful as comparative trace elements and are exhaustively reviewed in the second part of the analysis by neutron activation in chapter 8. As far as the main elements were concerned these were derived by electron beam micro-probe analysis at the Department of Geology, University of Durham. The experimental notes appear at the end of this chapter. The oxides most accurately available by this method were SiO_2 , Al_2O_3 , FeO , MnO , MgO , CaO , Na_2O and K_2O . The tabulated results from these analyses are shown in the following table. All the glasses are silica glasses and the results are expressed in terms of percentages by weight. All except no. 33 have durable compositions (i.e. more than ca. 60% SiO_2 and not more than 10% $\text{CaO} + \text{MgO}$). None are of the high potash "forest" type.

ANALYSIS OF MAJOR ELEMENTS

Sample No.	SiO ₂	Al ₂ O ₃	FeO	MnO	MgO	CaO	Na ₂ O	K ₂ O
1	67.7	2.65	0.85	0.64	1.56	7.30	17.2	0.96
2	67.0	2.54	0.85	0.77	0.79	7.20	17.2	1.50
3	68.9	2.56	0.91	0.64	0.71	7.34	17.0	0.96
4	67.9	2.14	0.85	0.0	1.63	7.11	15.7	1.47
5	66.6	2.56	0.91	0.73	0.95	7.17	16.7	1.38
6	70.7	2.54	0.85	0.0	0.51	9.38	14.2	0.26
7	67.3	2.48	0.69	0.94	0.81	6.36	17.6	1.78
8	68.7	2.80	0.77	0.11	0.59	9.42	15.5	0.36
9	67.3	3.24	0.54	1.08	0.72	7.71	14.9	2.48
10	65.2	2.66	0.96	0.07	1.10	6.52	20.3	0.71
11	67.8	2.01	0.35	1.19	0.72	6.46	19.3	0.35
12	63.9	2.70	1.20	0.14	1.12	7.42	20.1	0.90
13	64.4	2.57	1.12	0.14	1.08	7.09	19.9	0.73
14	68.6	2.97	0.32	1.26	0.51	7.82	14.6	2.28
15	66.7	2.96	0.50	0.21	0.85	8.94	13.4	4.80
16	71.3	2.14	0.32	0.0	0.59	5.28	18.4	0.63
17	67.3	2.46	0.85	1.74	0.89	6.19	16.4	2.26
18	64.5	2.91	1.49	2.19	0.94	5.07	18.7	0.51
19	61.9	2.50	1.30	2.05	1.17	7.04	19.0	0.79
20	68.6	2.14	0.46	0.98	0.66	5.43	19.4	0.34
21	-	-	-	-	-	-	-	-
22	69.9	3.00	0.32	0.94	0.51	7.56	16.6	0.63
23	65.0	2.57	1.15	1.98	1.04	6.34	19.2	0.59

Sample No.	SiO ₂	Al ₂ O ₃	FeO	MnO	MgO	CaO	Na ₂ O	K ₂ O
24	69.7	2.90	0.32	0.0	0.68	7.16	14.2	1.67
25	64.9	2.70	1.15	1.67	1.09	5.57	20.1	0.46
26	66.4	2.94	1.43	2.43	1.16	5.22	18.2	0.46
27	61.5	2.92	2.68	1.11	1.57	7.47	18.9	0.99
28	62.0	2.96	2.68	1.07	1.47	7.23	18.7	0.96
29	63.6	2.46	2.02	1.81	1.89	7.69	16.2	2.12
30	70.2	2.90	0.36	0.0	0.62	6.40	14.9	0.63
31	68.8	2.49	0.70	1.00	0.70	7.20	17.0	0.66
32	65.5	2.35	1.10	0.13	0.87	6.47	19.55	0.67
33	53.9	5.92	0.25	2.28	3.76	20.1	3.25	7.4
34	67.0	2.53	0.25	2.34	0.85	5.65	19.0	0.67
35	67.1	2.86	0.26	2.76	0.73	4.46	16.8	0.46
36	69.2	2.12	0.12	1.51	0.74	5.10	17.1	0.3
37 ^A	68.0	1.05	0.57	0.26	0.63	5.45	18.5	0.36
B	65.9	2.20	1.41	0.30	0.76	6.87	17.5	0.74
38	69.1	2.00	0.46	1.17	0.58	5.05	17.2	0.34
39	69.0	2.68	0.40	1.49	0.51	8.59	13.3	0.53
40	62.7	0.27	0.07	0.03	0.02	8.03	19.84	0.12
41	74.3	1.0	0.03	0.24	0.07	8.60	16.1	0.69
42	72.0	2.25	0.53	0.03	0.56	5.64	18.7	0.53
43	65.2	2.62	0.62	0.08	0.58	6.64	13.3	2.7
44	65.8	2.34	0.92	0.64	0.72	6.48	17.7	0.99
45	68.3	2.42	0.94	0.74	0.92	7.18	18.4	0.88
46	72.4	2.78	0.49	0.04	0.52	6.20	16.1	0.68

Sample No.	SiO ₂	Al ₂ O ₃	FeO	MnO	MgO	CaO	Na ₂ O	K ₂ O
47	69.7	3.49	0.64	0.06	0.80	8.04	17.1	0.90
48	69.7	3.21	0.60	0.05	0.79	7.83	17.3	0.88
49	68.4	2.38	0.84	1.73	1.35	5.90	19.3	1.51
50	69.2	2.22	0.57	0.04	0.77	8.31	18.8	0.59
51	67.3	3.21	0.51	0.08	0.71	10.4	16.3	0.83
52	69.3	2.55	0.60	0.06	0.77	9.33	16.0	1.0
53	63.6	1.92	1.26	0.24	1.43	7.81	16.6	1.87
54	69.6	1.01	0.30	0.61	5.43	6.45	12.2	2.76
55	69.3	2.67	0.69	0.48	0.81	8.12	15.4	1.51
56	68.2	2.61	0.85	0.52	0.66	6.96	16.7	1.11
57	65.9	2.49	1.08	0.64	0.69	6.48	16.3	0.78
58	63.6	1.47	1.00	2.48	1.80	9.58	15.0	3.24
59	68.6	2.00	0.70	1.09	0.99	7.17	17.8	1.32
60	65.3	2.85	0.41	0.00	0.74	7.37	16.3	1.23
61	68.9	2.77	0.49	0.05	0.75	7.46	14.9	0.70
62	66.2	2.41	0.89	2.10	0.77	7.04	17.8	1.22
63	65.8	2.45	1.11	0.35	2.09	7.64	17.3	1.33
64	69.6	2.69	0.34	1.34	0.51	8.25	14.5	0.63
65	66.4	2.56	1.08	0.54	0.52	6.97	14.0	5.20
66	69.4	2.80	0.46	1.10	0.37	7.54	15.3	1.61
67	68.1	3.14	0.65	1.50	0.51	8.47	15.4	0.55
68	70.5	2.12	0.53	0.30	0.47	6.38	18.1	0.58
69	67.9	2.99	0.48	+	0.69	7.97	16.2	0.62

Sample No.	SiO ₂	Al ₂ O ₃	FeO	MnO	MgO	CaO	Na ₂ O	K ₂ O
A	69.6	2.28	1.15	+	0.68	5.91	13.2	3.86
70 _B	71.3	2.24	0.47	+	0.67	5.77	15.5	0.69
71	73.9	2.90	0.46	+	0.38	6.35	13.3	0.68
72	71.4	3.05	0.40	0.0	0.50	7.24	13.2	1.65
73	68.4	2.64	1.16	0.40	0.75	7.00	15.4	3.05
74	67.9	2.60	0.70	0.40	0.70	7.92	16.9	0.92
75	64.3	3.21	2.02	0.64	1.31	6.89	17.9	1.95
76	69.2	3.28	0.59	1.24	0.43	8.66	16.0	0.63
77	71.4	2.58	0.39	0.0	0.35	6.04	14.9	2.41
78	66.7	2.46	1.16	1.0	0.83	6.75	16.9	1.86
79	68.2	2.58	0.50	0.0	0.48	6.74	16.8	1.52
80	66.0	2.03	0.41	1.23	1.13	6.53	21.3	0.34
81	68.5	2.17	0.49	1.23	0.87	6.49	18.5	0.72
82	63.4	2.52	1.21	1.53	1.13	8.76	20.5	0.47
83	59.8	2.92	1.21	2.01	0.81	3.83	18.7	0.76
84	65.9	2.88	1.40	2.19	0.88	4.84	19.3	1.31
85	68.6	2.27	0.71	0.99	0.96	5.81	19.8	0.24
86	69.5	2.82	0.33	0.0	0.70	7.90	14.7	1.66
87	65.3	1.74	0.65	0.17	1.76	9.37	18.3	1.27
88	63.9	2.96	2.86	0.99	1.45	7.45	17.0	2.28
89	63.8	2.93	2.84	1.13	1.60	7.43	17.3	0.93
90	66.7	3.15	0.54	0.0	0.77	10.5	16.1	0.67
91	62.4	2.11	1.23	0.28	1.82	8.65	19.7	1.46
92	65.7	2.58	0.69	1.46	0.81	4.94	21.1	0.37

Sample No.	SiO ₂	Al ₂ O ₃	FeO	MnO	MgO	CaO	Na ₂ O	K ₂ O
93	63.0	2.52	1.92	1.64	1.21	6.63	20.1	0.79
94	64.2	2.67	1.23	0.25	1.26	7.80	19.4	0.88
95	71.6	2.35	0.46	0.11	0.72	6.00	15.2	0.88

The results tabulated above illustrate the apparent similarities of these soda-lime glasses. With the exception of sample 33 which is discussed below, the elements always lie within a similar range. In certain samples the percentages of various elements are occasionally above or below this range, but there seems to be no system or order among these anomalies to relate the samples chronologically or by place of discovery. The range of SiO₂ stands between 61-74% and is in keeping with other known analyses of soda-lime glasses. CaO (ca.5-9%) and Na₂O (ca.13-19%) are similarly recorded from elsewhere. The elements with lower percentages show relatively greater variation. MnO is the most variable of these with nine samples containing more than two per cent and eleven in which the element is not present. The latter group of samples cannot be related to any known factor. The sporadic use of manganese as a decolourant may be inferred, although the spectrum of colours of the eleven samples makes this unlikely. The presence of iron (FeO) is generally contained below 1% apart from six examples (27,28,29, 75,88 and 89) which contain more than double this quantity. Al₂O₃ is usually maintained between 2-3%, Na₂O between 0.5-1.5% and K₂O between

0.5-2%. In the last element five samples (15,58,65,70a and 73) are all noticeably higher. Sample 65 contains over 5% K_2O .

Sample 33 is clearly different from the others. It is noticeably lower in SiO_2 (54%) and Na_2O (3%) and relatively high in CaO (20%), Al_2O_3 (6%), MgO (4%) and K_2O (7%). Proportionally these percentages are not dissimilar to analyses of 'weald' glass particularly in regard to the weights of both CaO and K_2O . The vessel itself (639) is dated to the context of the Early Roman Iron Age and is consequently one of the earliest dated samples included. The colour, a heavy dark green, is unique among Scandinavian glass of the first millennium. The analyses indicate that this is not of the usual soda-lime variety of glass and strongly suggest the use of different materials in manufacture.

The remaining ninety-three samples (sample 21 was not analysed by this method) show no such obvious dissimilarities. At this superficial level it is impossible to draw any conclusions and another method must be established to examine the data further.

A major problem in the interpretation of analyses lies in the apparent complexity of the individual elements and their relationships to each other. There is a strong need to find a simplified method of comparing the compositions. Significant variations which often lie in subtle combinations of elements may easily be missed. However, research into modern glass has produced some useful methods of investigation. El Shamy's work on the chemical durability of glasses depended on a method of quantitative analysis which is both relevant and appropriate to the glass samples in question from Scandinavia (9). The method is based on

the fact that although most analytical results are expressed in terms of the percentage of the oxide by weight, the elements exert their influence on the composition of the glass by way of the dispositions of their molecules in and around the silica network. Consequently it first becomes necessary to convert the weight percentages of the oxides to molecular percentages. This is carried out by using the molecular weight of the oxide and scaling the results to the total of one hundred. It is now noticeable that the molecular percentage compositions tend to be distinctly different from the percentage compositions by weight. The next stage is to express all the glass compositions in terms of three functions. The tabulated results for these processes and those which follow can be seen below. The three functions can be defined as the function of the silica (SiO_2) which takes into account the network properties of the oxide, the function of the alkaline oxides (Na_2O and K_2O) which take into account the network modifiers and the function of the alkaline earth oxides (MgO and CaO) which provide the network stabilisers. These three factors are denoted as " SiO_2 ", " R_2O " and " RO " respectively. The effect of Alumina (Al_2O_3) must be considered in both the " SiO_2 " and " R_2O " equations. Alumina is trivalent and able to immobilise an alkaline ion. The effect can be allowed for by the addition of twice the molar percentage to the " SiO_2 " and by the subtraction of a single molar percentage from the " R_2O ". Thus the results of the analyses can be reduced to three figures formulated as follows and expressed in terms of molar percentages:

Network Formers	" SiO_2 "	$(\text{SiO}_2 + 2\text{Al}_2\text{O}_3)$.
Network Modifiers	" R_2O "	$(\text{Na}_2\text{O} + \text{K}_2\text{O} - \text{Al}_2\text{O}_3)$.
Network Stabilisers	" RO "	$(\text{MgO} + \text{CaO})$.

The figures are reproduced in the following table:

Sample No.		1	2	3	4	5	6
PERCENTAGE BY WEIGHT	SiO ₂	67.7	67.0	68.9	67.9	66.6	70.7
	K ₂ O	0.96	1.50	0.96	1.47	1.38	0.26
	Na ₂ O	17.2	17.2	17.0	15.7	16.7	14.2
	CaO	7.30	7.20	7.34	7.11	7.17	9.38
	MgO	1.56	0.79	0.71	1.63	0.35	0.51
	Al ₂ O ₃	2.65	2.54	2.56	2.14	2.56	2.94
MOLAR EQUIVALENT	SiO ₂	112.8	111.7	114.8	113.2	111.0	117.8
	K ₂ O	1.02	1.60	1.02	1.56	1.47	0.28
	Na ₂ O	27.7	27.7	27.4	25.3	26.9	22.9
	CaO	13.03	12.85	13.10	12.69	12.30	16.75
	MgO	3.90	1.97	1.77	4.07	2.37	1.27
	Al ₂ O ₃	2.65	2.54	2.56	2.14	2.56	2.94
	Total	161.10	158.36	160.65	158.96	157.1	161.94
MOLAR PERCENTAGE	SiO ₂	70.61	70.53	71.45	71.21	70.65	72.74
	K ₂ O	0.63	1.01	0.63	0.93	0.93	0.17
	Na ₂ O	17.19	17.49	17.05	15.91	17.12	14.14
	CaO	8.08	8.11	8.15	7.93	8.14	10.34
	MgO	2.42	1.24	1.10	2.56	1.50	0.78
	Al ₂ O ₃	1.64	1.60	1.59	1.34	1.62	1.81
	Total	99.97	99.98	99.97	99.98	99.96	99.98
	"SiO ₂ "	73.29	73.73	74.63	73.89	73.89	76.36
	"R ₂ O"	16.18	16.90	16.06	15.55	16.43	12.50
	"RO"	10.50	9.35	9.25	10.54	9.64	11.12
	Total	99.97	99.93	99.94	99.98	99.96	99.98

Sample No.		7	8	9	10	11	12
PERCENTAGE BY WEIGHT	SiO ₂	61.3	68.7	67.3	65.2	67.8	63.9
	K ₂ O	1.78	0.36	0.48	0.71	0.35	0.90
	Na ₂ O	17.6	15.5	14.9	20.8	19.3	20.1
	CaO	6.36	5.42	7.71	6.52	6.46	7.42
	MgO	0.31	0.59	0.72	1.10	0.72	1.13
	Al ₂ O ₃	2.48	2.50	3.24	2.66	2.01	2.70
MOLAR EQUIVALENT	SiO ₂	112.8	114.5	112.1	103.6	113.0	106.5
	K ₂ O	1.89	0.38	0.51	0.76	0.37	0.96
	Na ₂ O	23.4	25.0	24.0	33.5	31.1	32.4
	CaO	11.35	16.34	13.76	11.64	11.53	13.25
	MgO	2.02	1.47	1.80	2.75	1.80	2.82
	Al ₂ O ₃	2.48	2.50	3.24	2.66	2.01	2.70
	Total	158.94	160.67	155.41	159.91	159.81	158.63
MOLAR PERCENTAGE	SiO ₂	70.97	71.26	72.13	67.91	70.70	67.13
	K ₂ O	1.19	0.24	0.33	0.48	0.23	0.60
	Na ₂ O	17.87	15.56	15.44	20.95	19.46	20.42
	CaO	7.14	10.47	8.85	7.23	7.07	8.35
	MgO	1.27	0.91	1.16	1.72	1.12	1.77
	Al ₂ O ₃	1.56	1.56	2.08	1.66	1.25	1.70
	Total	100.0	100.00	99.99	100.0	99.83	99.97
	"SiO ₂ "	74.09	74.38	76.29	71.23	73.20	70.53
	"R ₂ O"	17.50	14.24	13.69	19.77	18.44	19.32
	"RO"	8.41	11.38	10.01	9.00	8.13	10.12
	Total	100.00	100.00	99.99	100.00	99.83	99.37

Sample No.		13	14	15	16	17	18
PERCENTAGE BY WEIGHT	SiO ₂	64.4	68.6	66.7	71.3	67.3	64.5
	K ₂ O	0.73	2.28	4.80	0.63	2.26	0.51
	Na ₂ O	19.9	14.6	13.4	18.4	16.4	18.7
	CaO	7.09	7.82	8.94	5.28	6.19	5.07
	MgO	1.08	0.51	0.85	0.59	0.89	0.94
	Al ₂ O ₃	2.57	2.97	2.96	2.14	2.46	2.91
MOLAR EQUIVALENT	SiO ₂	107.3	114.3	111.2	118.8	112.2	107.5
	K ₂ O	0.78	2.42	5.11	0.67	2.24	0.54
	Na ₂ O	32.1	23.5	21.6	29.7	26.5	30.2
	CaO	12.66	13.96	15.96	9.42	11.05	9.05
	MgO	2.70	1.27	2.12	1.47	2.22	2.35
	Al ₂ O ₃	2.57	2.97	2.96	2.14	2.46	2.91
	Total	153.11	153.42	158.95	162.2	156.67	152.55
MOLAR PERCENTAGE	SiO ₂	67.36	72.13	69.96	73.24	71.61	70.46
	K ₂ O	0.49	1.53	3.21	0.41	1.42	0.35
	Na ₂ O	20.30	14.83	13.59	18.31	16.91	19.79
	CaO	8.01	8.81	10.04	5.80	7.05	5.93
	MgO	1.71	0.30	1.33	0.90	1.41	1.54
	Al ₂ O ₃	1.63	1.37	1.86	1.31	1.57	1.90
	Total	100.00	99.97	99.99	99.97	99.97	99.97
	"SiO ₂ "	71.12	75.87	73.63	75.86	74.75	74.26
	"R ₂ O"	19.16	14.49	14.94	17.41	16.76	18.24
	"RO"	9.72	9.61	11.37	6.70	8.46	7.47
	Total	100.00	99.97	99.99	99.97	99.97	99.97

Sample No.		19	20	21	22	23	24
PERCENTAGE BY WEIGHT	SiO ₂	61.9	68.6		69.9	65.0	69.7
	K ₂ O	0.79	0.34		0.63	0.59	1.67
	Na ₂ O	19.0	19.4		16.6	19.2	14.2
	CaO	7.04	5.43		7.56	6.34	7.16
	MgO	1.17	0.66		0.51	1.04	0.63
	Al ₂ O ₃	2.50	2.14		3.00	2.57	2.90
MOLAR EQUIVALENT	SiO ₂	103.1	114.3		116.5	118.3	116.1
	K ₂ O	0.34	0.36		0.67	0.62	1.78
	Na ₂ O	30.6	31.3		26.8	31.0	22.9
	CaO	12.57	9.69		13.50	11.32	12.78
	MgO	2.92	1.65		1.27	2.60	1.70
	Al ₂ O ₃	2.50	2.14		3.00	2.57	2.90
	Total	152.53	159.64		161.74	166.41	153.16
MOLAR PERCENTAGE	SiO ₂	67.59	71.68		72.03	71.09	73.41
	K ₂ O	0.55	0.22		0.41	0.37	1.13
	Na ₂ O	20.06	19.63		16.57	18.63	14.48
	CaO	8.24	6.07		8.35	6.30	8.03
	MgO	1.91	1.03		0.79	1.56	1.07
	Al ₂ O ₃	1.63	1.34		1.85	1.54	1.93
	Total	99.98	99.97		100.00	99.99	100.0
	"SiO ₂ "	70.85	74.36		75.73	74.17	77.07
	"R ₂ O"	18.93	18.51		15.13	17.46	13.78
	"RO"	10.15	7.10		9.14	8.36	3.15
	Total	99.98	99.9		100.00	99.99	100.0

Sample No.		25	26	27	28	29	30
PERCENTAGE BY WEIGHT	SiO ₂	64.9	66.4	61.5	62.0	63.6	70.2
	K ₂ O	0.46	0.46	0.99	0.96	2.12	0.63
	Na ₂ O	20.1	18.2	18.9	18.7	16.2	14.9
	CaO	5.57	5.22	7.47	7.23	7.69	6.40
	MgO	1.09	1.16	1.57	1.47	1.89	0.62
	Al ₂ O ₃	2.70	2.84	2.92	2.96	2.46	2.90
MOLAR EQUIVALENT	SiO ₂	108.1	110.6	102.5	103.3	106.0	117.0
	K ₂ O	0.48	0.48	1.05	1.02	2.26	0.67
	Na ₂ O	32.4	29.4	33.5	33.2	26.1	24.0
	CaO	9.94	9.32	13.33	12.91	13.73	11.42
	MgO	2.72	2.90	3.92	3.67	4.72	1.55
	Al ₂ O ₃	2.70	2.94	2.92	2.96	2.46	2.90
	Total	156.34	155.64	154.22	154.06	155.27	157.54
MOLAR PERCENTAGE	SiO ₂	69.14	71.06	66.46	67.05	68.27	74.27
	K ₂ O	0.31	0.31	0.68	0.66	1.46	0.43
	Na ₂ O	20.72	18.89	19.78	19.60	16.81	15.23
	CaO	6.36	5.99	8.64	8.33	8.84	7.25
	MgO	1.74	1.86	2.54	2.38	3.04	0.93
	Al ₂ O ₃	1.73	1.89	1.89	1.92	1.58	1.84
	Total	100.00	100.00	99.99	99.99	100.00	100.00
	"SiO ₂ "	72.60	74.84	70.24	70.89	71.43	77.95
	"R ₂ O"	19.30	17.31	18.57	18.34	16.69	13.32
	"RO"	8.10	7.85	11.18	10.76	11.88	8.23
	Total	100.00	100.00	99.99	99.99	100.00	100.00

Sample No.		31	32	33	34	35	36
PERCENTAGE BY WEIGHT	SiO ₂	68.8	65.5	53.9	67.0	67.1	69.2
	K ₂ O	0.66	0.67	7.4	0.67	0.46	0.30
	Na ₂ O	17.0	19.55	3.25	19.0	16.8	17.1
	CaO	7.20	6.47	20.1	5.65	4.46	5.10
	MgO	0.70	0.87	3.76	0.85	0.73	0.74
	Al ₂ O ₃	2.49	2.35	5.92	2.53	2.86	2.12
MOLAR EQUIVALENT	SiO ₂	114.7	109.2	89.8	111.7	111.8	115.3
	K ₂ O	0.70	0.71	7.87	0.71	0.49	0.32
	Na ₂ O	27.4	31.5	5.24	30.6	27.1	27.6
	CaO	12.85	11.55	35.89	10.03	7.96	9.10
	MgO	1.76	2.17	9.40	2.12	1.32	1.85
	Al ₂ O ₃	2.49	2.35	5.92	2.53	2.86	2.12
	Total	159.39	157.48	154.12	157.74	152.03	156.29
MOLAR PERCENTAGE	SiO ₂	71.74	69.34	58.26	70.81	73.54	73.77
	K ₂ O	0.44	0.45	5.11	0.45	0.32	0.20
	Na ₂ O	17.14	20.00	3.40	19.40	17.83	17.66
	CaO	8.04	7.33	23.29	6.39	5.24	5.82
	MgO	1.09	1.38	6.10	1.34	1.20	1.13
	Al ₂ O ₃	1.56	1.49	3.84	1.60	1.88	1.36
	Total	100.00	99.99	100.00	99.99	100.01	99.99
	"SiO ₂ "	74.86	72.32	65.94	74.01	77.30	76.49
	"R ₂ O"	16.02	18.96	4.67	18.25	16.27	16.50
	"RO"	9.13	8.71	29.39	7.73	6.44	7.00
	Total	100.01	99.99	100.00	99.99	100.01	99.99

Sample No.		37 _A	37 _B	38	39	40	41
PERCENTAGE BY WEIGHT	SiO ₂	68.0	65.9	69.1	69.0	62.7	74.3
	K ₂ O	0.36	0.74	0.34	0.53	0.12	0.69
	Na ₂ O	18.5	17.5	17.2	13.3	19.84	16.1
	CaO	5.45	6.87	5.05	8.39	8.03	3.6
	MgO	0.63	0.76	0.58	0.51	00.02	0.07
	Al ₂ O ₃	2.05	2.20	2.00	2.68	0.27	1.00
MOLAR EQUIVALENT	SiO ₂	113.3	109.8	115.2	115.0	104.5	123.8
	K ₂ O	0.38	0.78	0.36	0.56	0.13	0.73
	Na ₂ O	29.8	28.2	27.7	21.5	32.0	26.0
	CaO	9.73	12.26	9.01	14.93	14.33	15.35
	MgO	1.57	1.90	1.45	1.27	0.05	0.17
	Al ₂ O ₃	2.05	2.20	2.00	2.63	0.27	1.00
	Total	156.83	155.14	155.74	155.99	151.28	167.05
MOLAR PERCENTAGE	SiO ₂	72.24	70.77	73.98	73.72	69.08	74.11
	K ₂ O	0.24	0.50	0.23	0.36	0.08	0.44
	Na ₂ O	19.00	18.08	17.79	13.78	21.15	15.56
	CaO	6.20	7.90	5.79	9.60	9.47	9.19
	MgO	1.00	1.22	0.93	0.81	0.03	0.10
	Al ₂ O ₃	1.31	1.42	1.23	1.72	0.18	0.60
	Total	99.99	99.99	100.00	99.99	99.99	100.00
	"SiO ₂ "	74.86	73.61	76.54	77.16	69.44	75.31
	"R ₂ O"	17.93	17.26	16.74	12.42	21.05	15.40
	"RO"	7.20	9.12	6.72	10.41	9.50	9.29
	Total	99.99	99.99	100.00	99.99	99.99	100.00

Sample No.		42	43	44	45	46	47
PERCENTAGE BY WEIGHT	SiO ₂	72.0	65.2	65.8	68.3	72.4	69.7
	K ₂ O	0.58	2.7	0.99	0.88	0.68	0.90
	Na ₂ O	18.7	13.3	17.7	18.4	16.1	17.1
	CaO	5.64	6.64	6.48	7.18	6.20	8.04
	MgO	0.56	0.58	0.72	0.92	0.52	0.80
	Al ₂ O ₃	2.25	2.62	2.34	2.42	2.78	3.49
MOLAR EQUIVALENT	SiO ₂	120.0	108.7	109.7	113.8	120.7	116.2
	K ₂ O	0.62	2.87	1.05	0.94	0.72	0.95
	Na ₂ O	27.4	21.5	28.5	29.7	26.0	27.6
	CaO	10.57	11.85	11.57	12.82	11.07	14.35
	MgO	1.40	1.45	1.80	2.30	1.30	2.00
	Al ₂ O ₃	2.25	2.62	2.34	2.42	2.78	3.49
	Total	161.74	148.99	154.96	161.98	162.57	164.59
MOLAR PERCENTAGE	SiO ₂	74.19	72.96	70.79	70.26	74.24	70.60
	K ₂ O	0.38	1.93	0.68	0.58	0.44	0.58
	Na ₂ O	16.94	14.43	18.39	18.34	15.99	16.77
	CaO	6.23	7.95	7.47	7.91	6.81	8.72
	MgO	0.87	0.97	1.16	1.42	0.80	1.21
	Al ₂ O ₃	1.39	1.76	1.51	1.49	1.71	2.12
	Total	100.00	100.00	100.00	100.00	99.99	100.00
	"SiO ₂ "	76.97	76.48	73.81	73.24	77.66	74.84
	"R ₂ O"	15.93	14.60	17.56	17.43	14.72	15.23
	"RO"	7.10	8.92	8.63	9.33	7.61	9.93
	Total	100.00	100.00	100.00	100.00	99.99	100.00

Sample No.		48	49	50	51	52	53
PERCENTAGE BY WEIGHT	SiO ₂	69.7	68.4	69.2	67.3	69.3	63.6
	K ₂ O	0.88	1.51	0.59	0.83	1.00	1.87
	Na ₂ O	17.3	19.3	18.8	16.3	16.0	16.6
	CaO	7.83	5.90	8.31	10.4	9.33	7.81
	MgO	0.79	1.35	0.77	0.71	0.77	1.43
	Al ₂ O ₃	3.21	2.38	2.22	3.21	2.55	1.92
MOLAR EQUIVALENT	SiO ₂	116.2	114.0	115.3	112.2	115.5	106.0
	K ₂ O	0.94	1.60	0.62	0.88	1.06	1.99
	Na ₂ O	27.9	31.1	30.3	26.3	25.8	26.3
	CaO	13.98	10.53	14.83	18.57	16.66	13.94
	MgO	1.97	3.37	1.92	1.77	1.92	3.57
	Al ₂ O ₃	3.21	2.38	2.22	3.21	2.55	1.92
	Total	164.20	162.98	165.19	162.53	163.49	154.22
MOLAR PERCENTAGE	SiO ₂	70.77	69.95	69.80	68.86	70.65	68.73
	K ₂ O	0.57	0.98	0.38	0.54	0.65	1.29
	Na ₂ O	16.99	19.08	18.34	16.14	15.78	17.38
	CaO	8.51	6.46	8.98	11.40	10.19	9.04
	MgO	1.20	2.07	1.16	1.09	1.17	2.31
	Al ₂ O ₃	1.95	1.46	1.34	1.97	1.56	1.25
	Total	99.99	100.00	100.00	100.00	100.00	100.00
	"SiO ₂ "	74.67	72.37	72.48	72.80	73.77	71.23
	"R ₂ O"	15.61	18.60	17.38	14.71	14.87	17.42
	"RO"	9.71	8.53	10.14	12.49	11.36	11.35
	Total	99.99	100.00	100.00	100.00	100.00	100.00

Sample No.		54	55	56	57	58	59
PERCENTAGE BY WEIGHT	SiO ₂	69.6	69.3	68.2	65.9	63.6	68.6
	K ₂ O	2.76	1.51	1.11	0.78	3.24	1.32
	Na ₂ O	12.2	15.4	16.7	16.3	15.0	17.8
	CaO	6.45	8.12	6.96	6.48	9.58	7.17
	MgO	5.43	0.81	0.66	0.69	1.80	0.99
	Al ₂ O ₃	1.01	2.67	2.61	2.49	1.47	2.00
MOLAR EQUIVALENT	SiO ₂	116.0	115.5	113.7	109.8	106.0	114.3
	K ₂ O	2.94	1.61	1.18	0.83	3.45	1.40
	Na ₂ O	19.7	24.8	26.9	26.3	24.2	28.7
	CaO	11.51	14.50	12.42	11.57	17.10	12.80
	MgO	13.57	2.02	1.65	1.72	4.50	2.47
	Al ₂ O ₃	1.01	2.67	2.61	2.49	1.47	2.00
	Total	164.73	161.10	158.46	152.71	156.72	161.67
MOLAR PERCENTAGE	SiO ₂	70.42	71.69	71.75	71.90	67.64	70.70
	K ₂ O	1.78	0.99	0.74	0.54	2.20	0.87
	Na ₂ O	11.96	15.39	16.98	17.22	15.44	17.75
	CaO	6.99	9.00	7.84	7.58	10.91	7.92
	MgO	8.24	1.25	1.04	1.13	2.87	1.53
	Al ₂ O ₃	0.61	1.66	1.65	1.63	0.94	1.24
	Total	100.00	99.98	100.00	100.00	100.00	100.01
	"SiO ₂ "	71.64	75.01	75.05	75.16	69.52	73.13
	"R ₂ O"	13.13	14.72	16.07	16.13	16.70	17.38
	"RO"	15.23	10.25	8.88	8.71	13.73	9.45
	Total	100.00	99.98	100.00	100.00	100.00	100.01

Sample No.		60	61	62	63	64	65
PERCENTAGE BY WEIGHT	SiO ₂	65.3	68.9	66.2	65.8	69.6	66.4
	K ₂ O	1.23	0.70	1.22	1.33	0.63	5.20
	Na ₂ O	16.3	14.9	17.8	17.3	14.5	14.0
	CaO	7.37	7.46	7.04	7.64	3.25	6.97
	MgO	0.74	0.75	0.77	2.09	0.51	0.52
	Al ₂ O ₃	2.85	2.77	2.41	2.45	2.69	2.56
MOLAR EQUIVALENT	SiO ₂	108.8	114.8	110.3	109.7	116.0	110.7
	K ₂ O	1.30	0.74	1.30	1.41	0.67	5.53
	Na ₂ O	26.3	24.0	28.7	27.9	23.4	22.6
	CaO	13.16	13.32	12.57	13.64	14.73	12.44
	MgO	1.85	1.87	1.92	5.22	1.27	1.30
	Al ₂ O ₃	2.85	2.77	2.41	2.45	2.69	2.56
	Total	154.26	157.15	157.20	160.32	158.76	155.13
MOLAR PERCENTAGE	SiO ₂	70.53	72.89	70.11	68.43	73.07	71.36
	K ₂ O	0.84	0.47	0.83	0.88	0.42	3.56
	Na ₂ O	17.05	15.24	18.26	17.40	14.74	14.57
	CaO	8.53	8.46	8.00	8.51	9.28	8.02
	MgO	1.20	1.19	1.22	3.26	0.80	0.34
	Al ₂ O ₃	1.85	1.76	1.53	1.53	1.69	1.65
	Total	100.00	100.01	100.00	100.01	100.00	100.00
	"SiO ₂ "	74.23	76.41	73.22	71.49	76.45	74.66
	"R ₂ O"	16.04	13.95	17.56	16.75	13.47	16.48
	"RO"	9.73	9.65	9.22	11.77	10.08	8.86
	Total	100.00	100.01	100.00	100.01	100.00	100.00

Sample No.		66	67	68	69	70 _A	70 _B
PERCENTAGE BY WEIGHT	SiO ₂	69.4	68.1	70.5	67.9	69.6	71.3
	K ₂ O	1.61	0.55	0.58	0.62	3.86	0.69
	Na ₂ O	15.3	15.4	18.1	16.2	13.2	15.5
	CaO	7.54	8.47	6.38	7.97	5.91	5.77
	MgO	0.37	0.51	0.47	0.69	0.68	0.67
	Al ₂ O ₃	2.80	3.14	2.12	2.99	2.28	2.24
MOLAR EQUIVALENT	SiO ₂	115.7	113.5	117.5	113.2	116.0	118.8
	K ₂ O	1.71	0.58	0.62	0.65	4.11	0.73
	Na ₂ O	24.7	24.8	29.2	26.1	21.3	25.0
	CaO	13.46	15.12	11.39	14.23	10.55	10.30
	MgO	0.92	1.27	1.17	1.72	1.70	1.67
	Al ₂ O ₃	2.30	3.14	2.12	2.99	2.28	2.24
	Total	159.29	158.41	162.00	158.89	155.94	158.74
MOLAR PERCENTAGE	SiO ₂	72.63	71.65	72.53	71.24	74.39	74.34
	K ₂ O	1.07	0.37	0.38	0.41	2.64	0.46
	Na ₂ O	15.51	15.66	18.02	16.43	13.66	15.75
	CaO	8.45	9.54	7.03	8.96	6.77	6.49
	MgO	0.58	0.30	0.72	1.08	1.09	1.05
	Al ₂ O ₃	1.76	1.98	1.31	1.88	1.46	1.41
	Total	100.00	100.00	99.99	100.00	100.01	100.00
	"SiO ₂ "	76.15	75.61	75.15	75.00	77.31	77.66
	"R ₂ O"	14.82	14.05	17.09	14.96	14.84	14.80
	"RO"	9.03	10.34	7.75	10.04	7.86	7.54
	Total	100.00	100.00	99.99	100.00	100.01	100.00

Sample No.		71	72	73	74	75	76
PERCENTAGE BY WEIGHT	SiO ₂	73.9	71.4	68.4	67.9	64.3	69.2
	K ₂ O	0.68	1.65	3.05	0.92	1.95	0.63
	Na ₂ O	13.3	13.2	15.4	16.9	17.9	16.0
	CaO	6.35	7.24	7.00	7.92	6.89	8.66
	MgO	0.38	0.50	0.75	0.70	1.31	0.43
	Al ₂ O ₃	2.90	3.05	2.64	2.60	3.21	3.28
MOLAR EQUIVALENT	SiO ₂	123.2	119.0	114.0	113.2	107.2	115.3
	K ₂ O	0.72	1.76	3.24	0.97	2.07	0.67
	Na ₂ O	21.5	21.3	24.8	27.3	28.9	25.8
	CaO	11.33	12.92	12.50	14.14	12.30	15.46
	MgO	0.95	1.25	1.87	1.75	3.27	1.07
	Al ₂ O ₃	2.90	3.05	2.64	2.60	3.21	3.28
	Total	160.6	159.28	159.05	159.96	159.95	161.58
MOLAR PERCENTAGE	SiO ₂	76.71	74.71	71.68	70.77	68.30	71.36
	K ₂ O	0.45	1.11	2.04	0.61	1.32	0.41
	Na ₂ O	13.39	13.37	15.59	17.07	18.41	15.97
	CaO	7.05	8.11	7.86	8.84	7.84	9.57
	MgO	0.59	0.78	1.18	1.09	2.08	0.66
	Al ₂ O ₃	1.18	1.91	1.66	1.63	2.05	2.03
	Total	100.00	99.99	100.01	100.01	100.00	100.00
	"SiO ₂ "	90.33	78.53	75.00	74.03	72.40	75.92
	"R ₂ O"	12.03	12.57	15.97	16.05	17.68	14.35
	"RO"	7.64	8.89	9.04	9.93	9.92	10.23
	Total	100.00	99.99	100.01	100.01	100.00	100.00

Sample No.		77	78	79	80	81	82
PERCENTAGE BY WEIGHT	SiO ₂	71.4	66.7	68.2	66.0	68.5	63.4
	K ₂ O	2.41	1.86	1.52	0.34	0.72	0.47
	Na ₂ O	14.9	16.9	16.8	21.3	18.5	20.5
	CaO	6.04	6.75	6.74	6.53	6.49	8.76
	MgO	0.35	0.83	0.48	1.13	0.87	1.13
	Al ₂ O ₃	2.53	2.46	2.58	2.03	2.17	2.52
MOLAR EQUIVALENT	SiO ₂	119.0	111.2	113.7	110.0	114.1	105.7
	K ₂ O	2.56	1.97	1.61	0.36	0.77	0.50
	Na ₂ O	24.0	27.2	27.1	34.4	29.8	33.1
	CaO	10.78	12.05	12.03	11.6	11.59	15.64
	MgO	0.87	2.07	1.20	2.83	2.18	2.83
	Al ₂ O ₃	2.58	2.46	2.58	2.03	2.17	2.52
	Total	159.79	156.95	158.22	161.28	160.61	160.29
MOLAR PERCENTAGE	SiO ₂	74.47	70.85	71.86	68.20	71.04	65.94
	K ₂ O	1.60	1.26	1.02	0.22	0.48	0.31
	Na ₂ O	15.02	17.33	17.13	21.33	18.55	20.65
	CaO	6.75	7.68	7.60	7.23	7.22	9.76
	MgO	0.54	1.32	0.76	1.75	1.36	1.77
	Al ₂ O ₃	1.61	1.57	1.63	1.25	1.35	1.57
	Total	99.99	100.01	100.00	99.99	100.00	100.00
	"SiO ₂ "	77.69	73.99	75.12	70.70	73.74	69.08
	"R ₂ O"	15.01	17.02	16.52	20.30	17.68	19.39
	"RO"	7.29	9.00	8.36	8.98	8.58	11.53
	Total	99.99	100.01	100.00	99.98	100.00	100.00

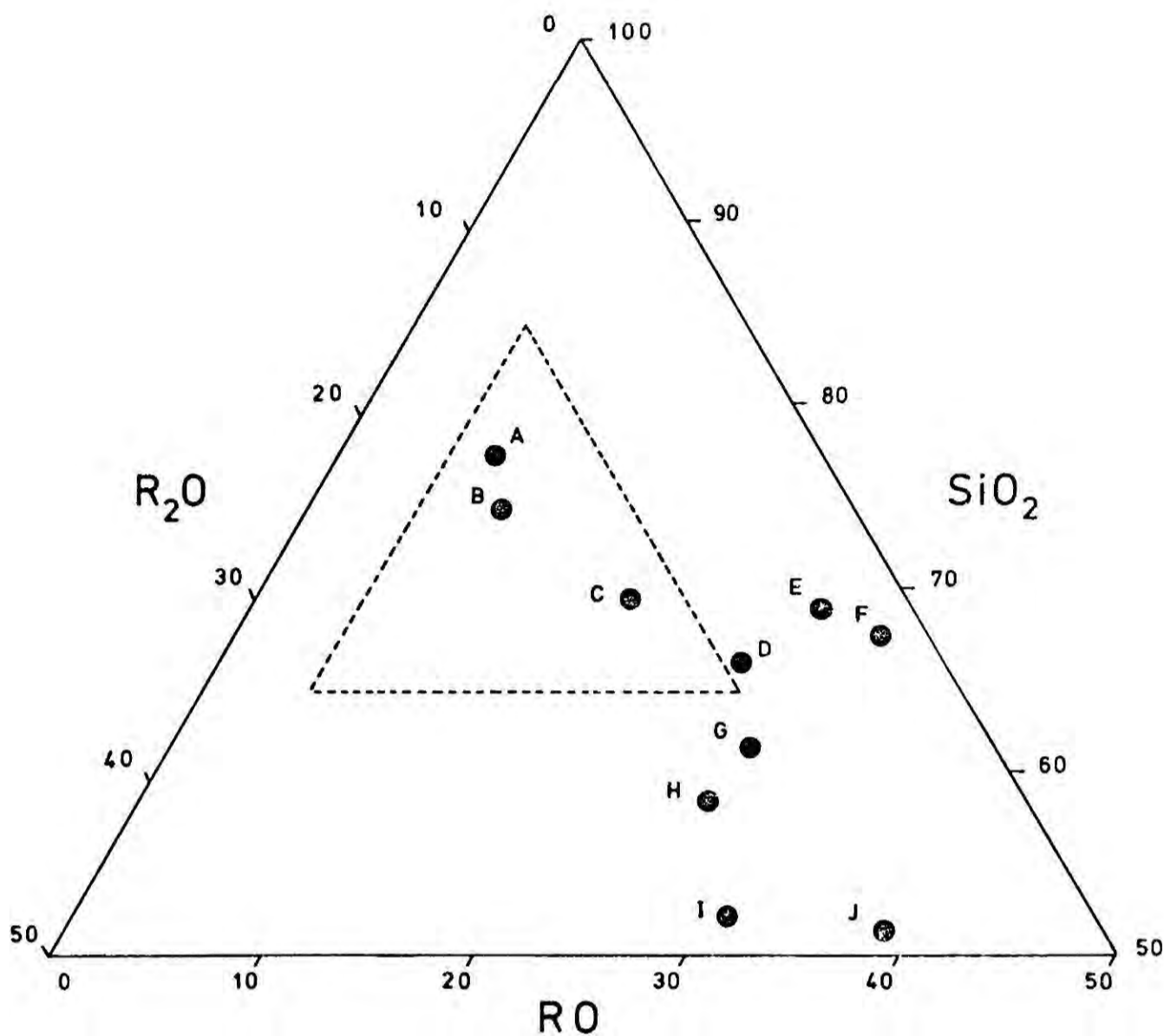
Sample No.		83	84	85	86	87	88
PERCENTAGE BY WEIGHT	SiO ₂	59.8	65.9	63.6	69.5	65.3	63.9
	K ₂ O	0.76	1.31	0.24	1.66	1.27	2.28
	Na ₂ O	18.7	19.3	19.8	14.7	18.3	17.0
	CaO	3.83	4.84	5.81	7.90	9.37	7.45
	MgO	0.81	0.88	0.96	0.70	1.76	1.45
	Al ₂ O ₃	2.92	2.88	2.27	2.82	1.74	2.96
MOLAR EQUIVALENT	SiO ₂	999.7	109.9	114.3	115.8	108.8	106.5
	K ₂ O	0.80	1.20	0.26	1.77	1.35	2.43
	Na ₂ O	30.1	31.1	31.9	23.7	29.5	27.4
	CaO	6.84	8.64	10.38	14.11	16.73	13.30
	MgO	2.03	2.20	2.40	1.75	4.40	3.63
	Al ₂ O ₃	2.92	2.88	2.27	2.82	1.74	2.96
	Total	142.39	155.92	161.51	159.95	162.52	156.22
MOLAR PERCENTAGE	SiO ₂	70.02	70.48	70.77	72.40	66.95	68.18
	K ₂ O	0.56	0.77	0.16	1.11	0.83	1.56
	Na ₂ O	21.14	19.95	19.95	14.82	18.15	17.54
	CaO	4.80	5.54	6.43	8.82	10.29	8.51
	MgO	1.43	1.41	1.49	1.09	2.71	2.32
	Al ₂ O ₃	2.05	1.85	1.41	1.76	1.07	1.39
	Total	100.00	100.00	100.01	100.00	100.00	100.00
	"SiO ₂ "	74.12	74.18	73.59	75.92	69.09	71.96
	"R ₂ O"	19.65	18.87	18.50	14.17	17.91	17.21
	"RO"	6.23	6.95	7.92	9.91	13.00	10.83
	Total	100.00	100.00	100.01	100.00	100.00	100.00

Sample No.		89	90	91	92	93	94	95
PERCENTAGE BY WEIGHT	SiO ₂	63.8	66.7	62.4	65.7	63.0	64.2	71.6
	K ₂ O	0.93	0.67	1.46	0.37	0.79	0.88	0.88
	Na ₂ O	17.3	16.1	19.7	21.1	20.1	19.4	15.2
	CaO	7.43	10.5	8.65	4.94	6.63	7.80	6.0
	MgO	1.60	0.77	1.82	0.81	1.21	1.26	0.72
	Al ₂ O ₃	2.93	3.15	2.11	2.58	2.52	2.67	2.35
MOLAR EQUIVALENT	SiO ₂	106.3	111.1	104.0	109.5	105.0	107.0	119.3
	K ₂ O	0.99	0.71	1.55	0.39	0.84	0.94	0.94
	Na ₂ O	27.9	25.9	31.8	34.0	32.4	31.3	24.5
	CaO	13.27	18.75	15.44	8.82	11.83	13.92	10.71
	MgO	4.00	1.93	4.55	2.02	3.02	3.15	1.80
	Al ₂ O ₃	2.93	3.15	2.11	2.58	2.52	2.67	2.35
	Total	155.39	161.54	159.45	157.31	155.61	158.93	159.56
MOLAR PERCENTAGE	SiO ₂	68.41	68.78	65.22	69.61	67.48	67.30	74.76
	K ₂ O	0.64	0.44	0.97	0.25	0.54	0.59	0.58
	Na ₂ O	17.95	16.03	19.94	21.61	20.82	13.69	15.35
	CaO	8.54	11.61	9.68	5.61	7.60	8.76	6.71
	MgO	2.57	1.19	2.85	1.28	1.94	1.98	1.12
	Al ₂ O ₃	1.89	1.95	1.32	1.64	1.62	1.68	1.47
	Total	100.01	100.00	99.98	100.00	100.00	100.00	99.99
	"SiO ₂ "	72.19	72.68	67.86	72.89	79.72	70.66	77.7
	"R ₂ O"	16.70	14.52	19.59	20.22	19.74	18.60	14.46
	"RO"	11.11	12.80	12.53	6.89	9.54	10.74	7.83
	Total	100.00	100.00	99.98	100.00	100.00	100.00	99.99

When the analyses of each sample have been reduced to these three variables and expressed as percentages they can be plotted graphically. Each sample can be represented by a single point by presenting the data on triangular co-ordinates. This method of procedure has been successfully carried out by the British Glass Industry Research Association to show that the durability of different groups of glass from certain dates and places is clearly represented by the clustering of the groups within the triangular graph (10). Durability depends to a large extent upon the silica (SiO_2) content, and thus only large variations within that element will produce clearly defined clustering. Nevertheless, the reduction of the major elements to three simple factors expressed in percentages can also reflect subtle combinations which may exist among the major elements and which are not immediately apparent in a preliminary study of the data. Because the values of the respective variables are so similar throughout the samples, one can hardly hope for clearly defined clusters, but rather for separate groupings surrounded by peripheral areas.

The individual points representing the three values (SiO_2 , R_2O and RO) of each sample are plotted in this manner in fig 33 to indicate their relation to the results of analyses from other known groups of glass from antiquity. There was no definite clustering within the general area covered by these Scandinavian glasses. The next stage is to apply various relevant criteria to the samples concerned. These criteria can be broadly defined as relating to location, chronology and typology. The first two hold considerable potential in that the majority of the samples are dated and that their places of discovery

FIG 33.



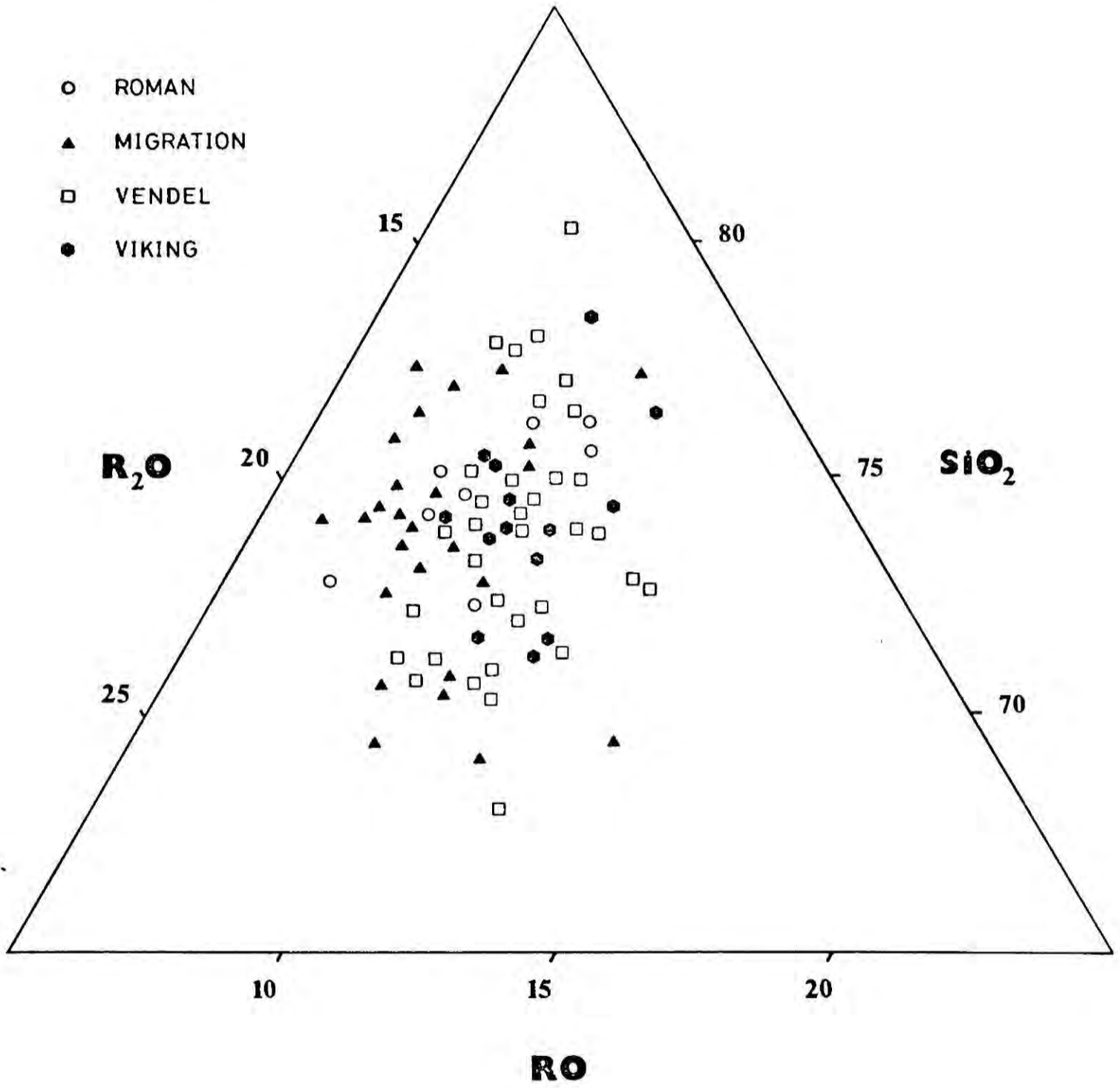
TRIANGULAR REPRESENTATION OF GLASS COMPOSITIONS

- | | | | |
|-----|-----------------------------|---------|-----------------|
| A | ANGLO-SAXON (MONKWEARMOUTH) | B | ROMAN |
| C,H | MEDIAEVAL (YORK) | D,E,F,G | POST-MEDIAEVAL |
| I | MEDIAEVAL (AUSTRIA) | J | MEDIAEVAL (ELY) |
- DOTTED TRIANGLE SHOWS APPROXIMATE POSITION OF SCANDINAVIAN GLASS

are known. Typology is less advantageous as many of the samples are from fragments with no visible typological attributes. Although both chronology and location seem at first sight valid criteria for this purpose, it should be remembered that the dating of the samples relates to the archaeological context of the glass vessel and not necessarily the vessel itself, and that the place of discovery of the vessel is not necessarily related to the place of manufacture.

The simplest method of approach is to attempt to cluster the samples (with the exception of no. 33) in terms of the usual Scandinavian chronological periods. This is shown in fig 34 where different symbols are used to represent samples from the Roman Iron Age, Migration Period, Vendel Period and Viking Period. The samples used here were only those whose datable contents lay firmly within one of these periods. Samples whose dating overlapped two periods were not included. This method did not show any clear groupings. I have already argued above (chapter I) that the production of glass may bear no relation whatsoever to the Scandinavian chronological periods which are defined by changes of style in various 'native' artefacts. At this stage the only conclusion to be made is that by this method there seems to be no relation between the glass analyses and the changes in the traditional chronology. In very general terms some grouping does occur but this is too nebulous to provide sound evidence. The samples from the Migration Period tend to group to the left of the graph and there is a cluster of Viking Period samples lying in the centre.

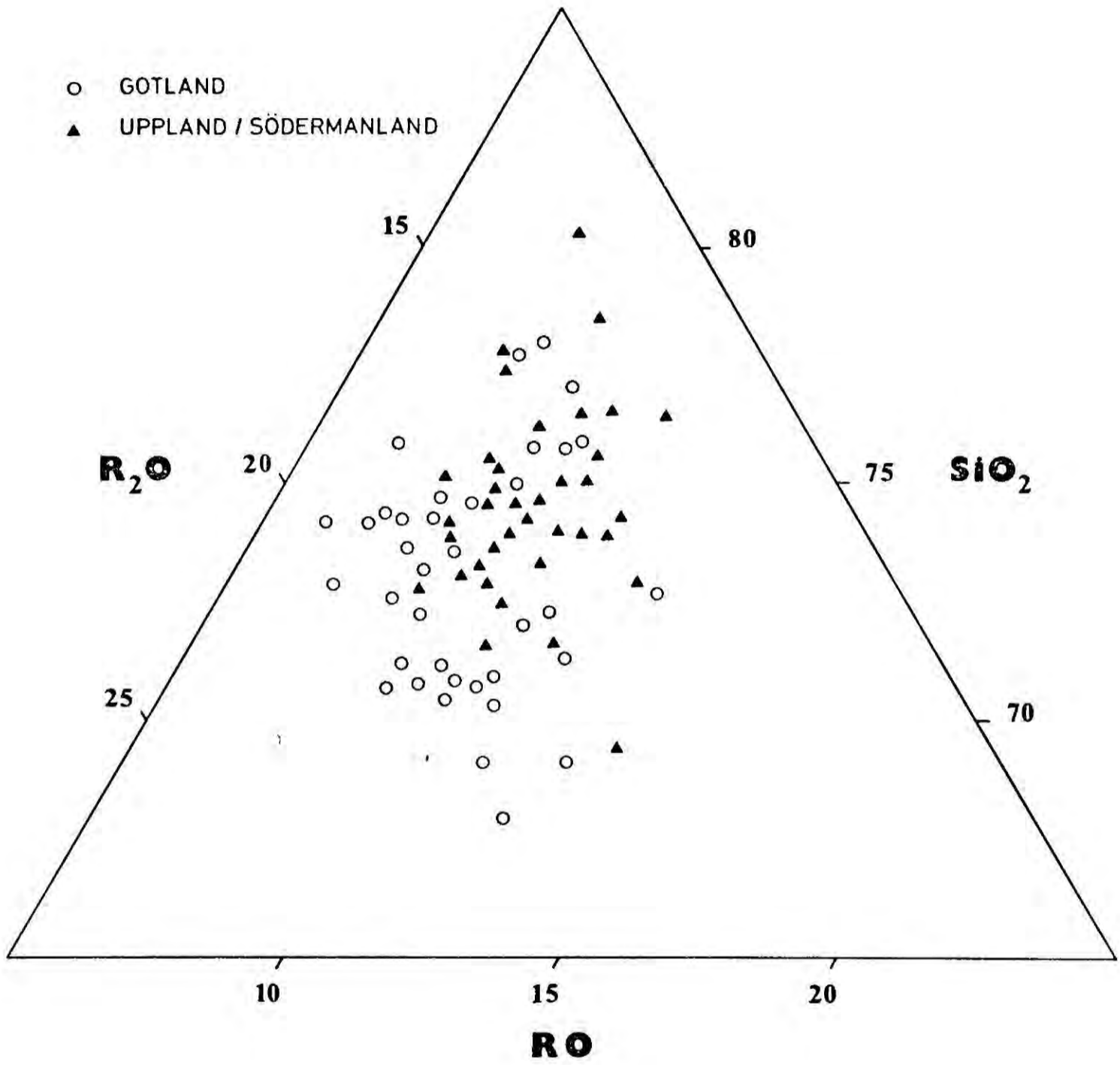
At this stage it is important to ask the significance of any



groupings which arise from the analyses. The variations between the major elements in the samples are so small that they can hardly reflect any specific human interference such as the deliberate addition of larger quantities of a particular element. This would have been immediately apparent in an initial examination of the results. Therefore any grouping which is defined on the graph must relate to a natural constituency of the raw material used in manufacture. The differences between the major elements are so slight that grouping can only emerge by defining these elements in combination, and this again points to variation in source material rather than in human interference. Therefore if groups of samples appear in clusters by this method one may conclude that each cluster represents a group of glasses manufactured using raw material from a specific area.

The next experimental factor to be applied to the graph concerns the location of the samples themselves. In terms of the wealth of burials the richest areas in Sweden can be said to lie in the Mälaren region and in Gotland. Both are sufficiently geographically distinct to be treated in isolation in this respect. As the majority of the samples are from these two areas they can be compared with some degree of accuracy. Both sets of samples are plotted in fig 35. All samples from these locations were used even although some were undated. This produced a total of 74 fragments. The Uppland/Södermanland samples tend to group to the top right of the graph, while the Gotlandic samples tend to group to the bottom left. An approximate line can be drawn between the two in the peripheral area, although this does not constitute a clear-cut division by any standards. It was shown in the discussion

FIG 35.



of typological analysis that there was a definite frequency distribution which spreads from west to east during the millennium. The final stage in this movement was from Gotland to E. Sweden. It was noticed that throughout the west/east shift there was an overlap period which approximately co-incided with the Vendel Period and it was suggested that perhaps two different centres of output existed, one supplying vessels up to a time somewhere in the sixth or seventh century and the other supplying vessels for the rest of the millennium.

If the samples from the overlap period are now removed from the graph a much clearer picture emerges (fig 36). This shows that the two groups of glasses illustrated here are distinctive or in other words that the compositions of their raw materials were different. The glasses removed from the graph were all those which were dated broadly to the Vendel Period. They are listed below together with the more accurate dating taken from the catalogue. The letter following the sample number refers to the area of origin i.e. Gotland, Uppland or Södermanland.

<u>Sample No.</u>		<u>Date</u>	<u>Sample No.</u>		<u>Date</u>
10	G	AD 600 - 700	50	S	AD 600 - 700
12	G	AD 550 - 600	51	S	AD 600 - 700
13	G	Vendel Period	52	S	AD 600 - 700
24	G	AD 600 - 650	55	U	AD 800
27	G	Vendel Period	60	U	Vendel Period
28	G	Vendel Period	61	U	Vendel Period
29	G	Vendel Period	65	U	AD 600 - 700
30	G	AD 600 - 650	69	U	AD 700 - 800

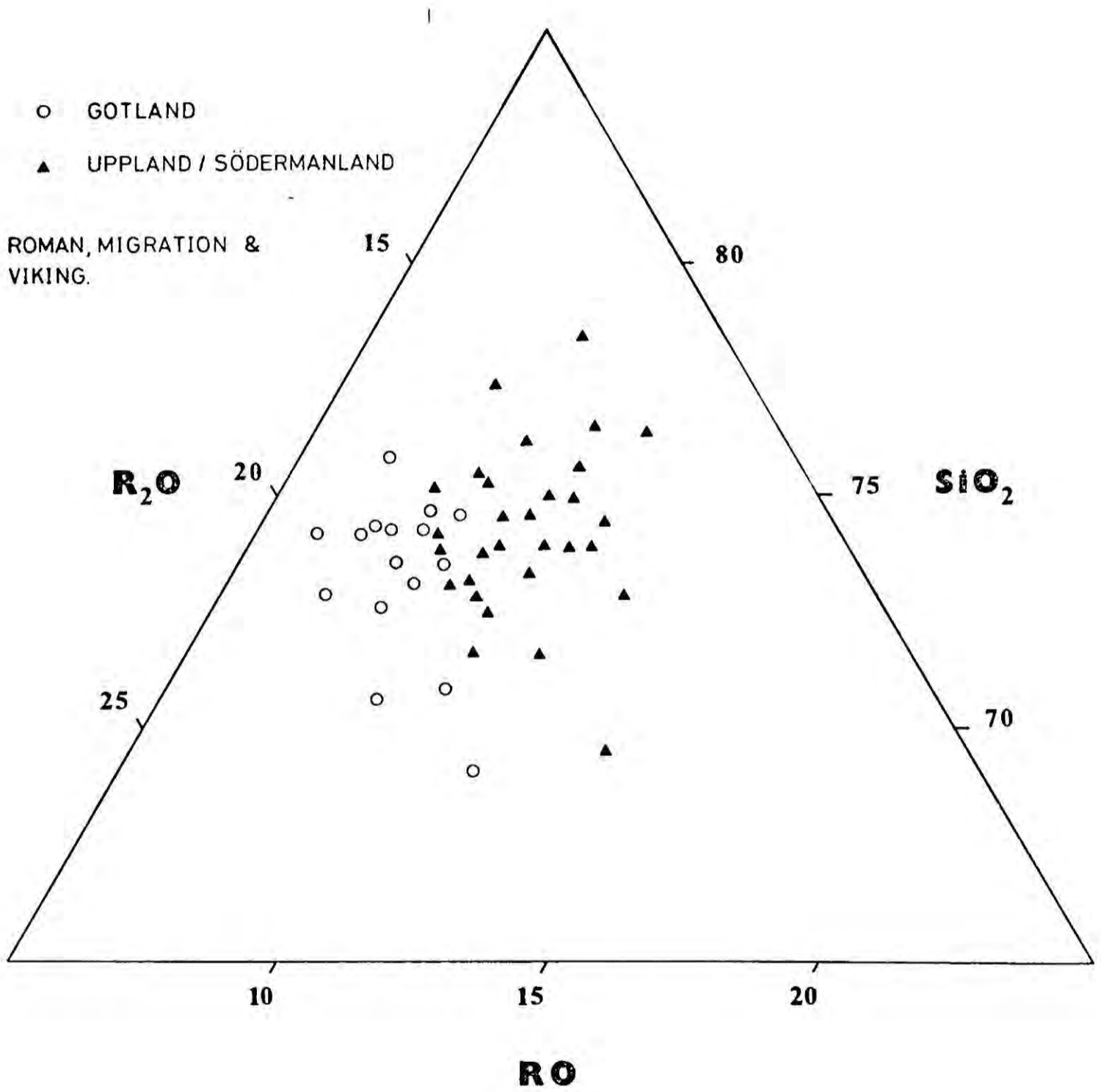
<u>Sample No.</u>		<u>Date</u>	<u>Sample No.</u>		<u>Date</u>
31	G	AD 550 - 600	71	U	AD 650 - 700
32	G	AD 550 - 600	88	G	Vendel Period
44	S	AD 700 - 800	89	G	AD 600 - 700
45	S	Vendel Period	90	G	AD 600 - 700
46	S	Vendel Period	91	G	AD 600 - 650
47	S	AD 700 - 800	93	G	AD 600 - 650
48	S	AD 700 - 800	94	G	Vendel Period

In some cases the dates refer to a period as small as 50 years, or in other cases to the whole Vendel Period (ca. AD 550/600 - 800). By examining these it may be possible to define even more clearly the possible date of changeover of the two types. The majority of the Gotlandic glasses which are closely dated appear to lie within the late sixth and seventh centuries. The samples from Uppland and Södermanland belong to the seventh and eighth centuries. A date of changeover occurring between ca. AD 650 - 750 seems plausible.

An obvious criticism of this is that it only uses a portion of the samples available and limits them chronologically. Nevertheless the removal of the overlap period samples is a valid one and merely applies a criterion already established by the frequency distribution method.

The credibility of this last graph (fig 36) is confirmed statistically by a χ^2 value of 30.7. The graph which included the overlap samples had a χ^2 validity of 20.0. Both are significant with the former being highly significant.

FIG 36.



One must still consider this as a hypothesis. It essentially produces more problems than it actually solves. It still does not explain fully the presence of other samples of various dates and places which appear on the total graph shown in fig 34. Other groupings may also exist although their defining criteria remain unknown. If one fully applies the hypothesis derived from the typological analysis one might expect to see the following features emerging.

- (1) The vessel-type influxes defined typologically might also appear defined chemically.
- (2) There may be a distinction chemically between the western and eastern groups of glasses.
- (3) In the event of the eastern products being locally made (ie at Helgo) evidence of the eastern glass types might appear as early as ca. AD 400.
- (4) A certain amount of interchange might take place between manufacturing areas (ie if vessels were made at Helgo their distribution may not necessarily be restricted to E. Sweden.

At this stage only (2) has been hesitantly ascertained. The Gotlandic examples are essentially distinct from those discovered in the Uppland and Södermanland regions apart from the Vendel Period.

(1) is more difficult to explain. Of the eight Roman finds which appear on the first graph only two are from Gotland (nos. 17 and 92). Other Roman dated finds which appear in the west are in Västmanland (no. 75) and in Uppland (no. 68). The position of both are in the Gotlandic

(ie western) half of the graph. The remaining eastern four consist of three from Uppland (nos. 64, 66 and 67) and from Dalsland (no. 9). This last example appears on the Uppland/Södermanland (ie eastern) side of the graph. The hypothesis is still valid. We have already established that Helgö was in existence by ca. AD 400. It is still conceivable that the Roman finds of the eastern group, all of which are dated to between ca. AD 200 - 400 could have been the products of the Helgö workshop. There is one find which confirms this theory from Uppland (no. 68). This is dated to between ca. AD 50 - 200. It appears on the Gotland as opposed to the Uppland side of the graph even although the place of discovery was in Uppland itself. As chemically it belongs to the Gotland group and is dated to a period before Helgö was known to exist the theory is strengthened. Had it appeared in the Uppland group then the theory would have been confounded.

The vessel influx of the fifth century is equally helpful. With three exceptions all the samples appear in the Gotlandic group. The three (nos. 39, 40 and 42) are all from burials in the east of Sweden in Medelpad and all are dated to the fifth century. Other samples from this period also from Medelpad appear in the Gotlandic group. One can perhaps assume that a certain amount of interplay existed here. These Medelpad graves were unusually richly furnished.

Assuming that the defining criteria are valid the following conclusions may be drawn from this analysis.

- (1) That there are two groups of glass represented here. The distinction is by no means a clear one but is sufficient to suggest the use of two different sources of raw material.

- (2) That according to the location of the finds one of these sources is western and one is eastern.
- (3) That the western glass existed between ca. AD 50 - 650/750 and the eastern from as early as the fourth century and continued to the end of the millennium.
- (4) That there was some interplay in the distribution between the two groups and that this was at its height in the Vendel Period.
- (5) That the western glasses were probably imported from the Rhineland and that the eastern glasses were possibly made locally (Helgö).

The limited number of samples available for analysis still make this conjectural. With further examples which could relate to the typological changes outlined in the typological analysis the picture might be confirmed further. Analysis of the Helgö material is also suggested.

Experimental Notes

The samples were analysed using a Cambridge Instrument Co. 'Geoscan' electron microprobe. The counting statistics for sodium and potassium gave rise to some uncertainty in the final percentages. This was caused by the low accelerating voltage and specimen current needed for the high sodium content of the glass. The given values for sodium and potassium can therefore have a variation of $\pm 1.5\%$ and $\pm 0.1\%$ respectively on the figures quoted. All the other elements are reliable only to the first decimal place. Each specimen was analysed at a number of points on a clean ground surface and an average value taken. The procedure also included computer correction for dead time and machine drift.

The standards used were CAM 66, P 6 (both glasses) and AP 17877 (apatite).

CHAPTER SEVEN - REFERENCES AND NOTES

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CHAPTER 8 - THE ANALYSIS OF TRACE ELEMENTS

The analysis of trace elements is traditionally a technique applied to outcrop materials such as flint, jade or obsidian whose chemical compositions may be geographically characteristic and allow simple classification by means of rare earth or other elements which are present in small quantities. A method frequently used on such materials is that of neutron activation analysis which involves the spectrographic measurement of gamma-ray emission from samples made radioactive by a high flux of thermal neutron radiation in a nuclear reactor. In most instances research in this field has been concerned with the relationship between artefacts and outcrop sources in an effort to clarify patterns of trade and distribution. At this level the problem is essentially a simple one in that the presence or characteristic quantities of certain elements in one outcrop source will be reflected in the composition of artefacts derived from the same source. The data from samples of known outcrops can be directly compared to data from selected artefacts. Work of this nature has been applied in many instances and with considerable success notably with obsidian and faience⁽¹⁾. In principle the process is non-destructive although in practice it is preferential to sample the object in question. In theory a sample of only a few milligrammes is acceptable although problems of handling may require this to be somewhat greater. The advantage of the method lies in its ability to detect and quantify elements (below one part per million (ppm) by weight) to an acceptable accuracy. This provides complementary data to that derived from the analysis of major elements (chapter 7). Glass is particularly suited

to neutron activation analysis. The composition is largely of silicon (here usually over 60%) which is not activated by the radiation to which the sample is subjected. The remaining elements are those which characterise the glass and therefore the gamma-ray emission is effectively limited to those elements which are archaeologically most useful.

The value of examining trace elements in glass has yet to be fully established and no work has been carried out by this method. The main problem is that glass is a man-made product and not a natural material. Although raw materials are used for its production the exact nature of those materials is basically unknown and their sources may be numerous. I assume here that the materials consist of alkaline matter (probably organic) and a substance with a high silicon content (sand or sand-stone). The metal itself is a compound of various chemicals and in these periods of time is unlikely to have existed without certain additives for colouring, decolouring or opacifying and therefore the potential for impurity is increased. Furthermore, a practice of reusing existing glass fragments as the basis for a better melt would make any such analysis worthless. None of these problems exist with artefacts derived totally from outcrop sources. Even if the analyses could differentiate between groups of glasses in terms of their trace elements there are still no 'basic sources' to which they could be related. The aim here can only be to establish groupings which by date and location of context can be related to groupings formulated by typological analysis and by the analysis of major elements (chapters 6 and 7 respectively). If such relationships exist then not only is the Scandinavian material open to

considerable re-interpretation but also the examination of trace elements is seen to be an effective and viable method of glass analysis.

The success of neutron activation analysis on glass depends on four factors. Firstly the assumption is that recognisable relationships between trace elements imply differences within the basic natural materials and that these differences reflect geographical separation, the extent of which is unknown. Secondly it assumes that any additive contained in the metal for technological purposes can be isolated. Thirdly it assumes that the practice of using existing fragments in a fresh melt either did not occur or made no difference to the presence or relationships of trace elements in the new glass. It is conceivable that if fragments were used for this purpose they would exist as workshop waste and therefore be of similar composition. Thus the trace element composition in the fresh melt would remain basically unchanged. Finally it assumes that areas of geographical distribution can be recognised despite trading activity.

Seventy-five samples were examined by this method. The experimental notes appear at the end of this chapter. The samples were the same as those used for the analysis of major elements and were examined after that method. Due to problems caused by radiation it would have been impossible to carry out the examination in the reverse order. In this way both methods could be utilised to their maximum extent. The only preparation needed for the samples was in freeing them from their resin mounts by soaking in an acetone solution.

Fourteen elements were identified and recorded for each sample including two (sodium and iron) already detected from the major element analysis. Where possible all elements were quantified with the exception of gold (Au) which existed in concentrations too small to be accurately recorded. However, the presence or absence is noted accordingly. Potassium (K) was detected but not measured. The full range of elements comprised of sodium (Na), scandium (Sc), iron (Fe), cobalt (Co), antimony (Sb), cesium (Cs), lanthanum (La), cerium (Ce), europium (Eu), samarium (Sm), terbium (Tb), hafnium (Hf), tantalum (Ta) and gold (Au). The concentrations are listed in the following tables. All values shown are in parts per million with the exception of sodium which is expressed as a percentage.

Sample	Na(%)	Sc	Fe	Co	Sb	Cs	La	Ce	Eu	Sm	Tb	Hf	Ta	Au
1	13.1	1.64	4580	11.3	1970	0.6	8.3	-	0-1	1.4	-	-	-	+
2	12.9	1.75	7960	33.2	1980	0.6	8.6	-	0-4	1.1	-	-	-	+
3	12.4	1.40	6300	10.0	1284	0.6	7.8	11.5	0-5	0.8	-	-	-	+
4	10.5	2.36	7000	55.7	82	47.4	5.0	20.5	0-5	0.9	0.7	-	-	+
5	12.4	1.85	8890	34.5	2610	0.6	9.2	-	0-3	1.5	-	-	-	+
7	12.5	2.28	4417	22.9	1537	6.43	6.1	-	0-6	0-3	-	-	-	+
8	12.0	2.28	1086	4.3	0.3	0.1	6.8	-	0.4	0.3	0.1	-	-	-
9	11.4	1.61	6232	10.5	0.6	0.1	7.9	-	0.5	0.3	0.1	1.3	-	+
11	14.6	1.15	3417	3.4	1.6	0.2	4.4	-	0.4	0.3	0.1	1.3	0.1	-
14	11.3	1.16	3371	8.1	2.0	-	6.1	-	0.5	0.3	-	1.5	-	-
16	16.2	1.06	3000	422	2700	3.0	5.7	-	0-3	0.4	-	-	-	+
17	12.0	2.46	7000	6.3	0.5	0.1	8.2	-	0.5	1.5	0.2	2.6	0.1	+
18	14.3	3.58	6510	5.7	2.9	0.1	9.3	-	0.3	1.9	-	4.4	0.2	+
19	14.2	3.64	10620	14.1	12.8	0.1	0.1	-	0.7	1.9	0.2	5.2	-	+
20	15.4	1.36	3840	5.1	3.0	0.2	2.0	8.8	0.4	1.3	0.1	1.5	0.1	+

Sample	Na(%)	Sc	Fe	Co	Sb	Cs	La	Ce	Eu	Sm	Tb	Hf	Ta	Au
21	14.1	3.38	10174	13.6	7.8	0.1	8.5	-	0.5	0.4	-	4.5	-	-
23	14.4	3.46	10807	11.9	12.9	0.1	8.8	-	0.6	0.4	-	5.6	-	-
24	11.0	1.11	2935	2.2	25.5	0.1	6.5	-	0.5	0.3	-	1.4	-	+
25	15.6	3.87	11387	9.4	3.0	0.1	9.5	-	0.6	0.4	-	5.0	-	-
26	13.4	4.52	13544	14.1	2.4	0.1	10.3	-	0.6	0.4	-	5.4	0.3	-
29	9.5	2.98	14346	36.3	48.5	0.1	9.4	-	0.7	0.3	-	2.5	0.9	+
30	9.3	1.47	4626	2.3	8.7	0.1	5.3	3.2	0.6	0.2	-	1.1	-	+
31	15.3	2.00	5110	3.1	159	1.9	7.4	-	0.7	0.8	-	-	-	-
32	17.2	3.29	12465	501	6.9	1.4	7.7	14.2	0.4	0.3	-	4.8	-	-
33	2.6	3.76	10306	7.9	0.4	1.7	13.2	-	0.4	0.3	0.3	4.8	0.1	-
34	15.5	4.40	12873	15.0	0.8	0.1	11.0	15.9	0.6	1.1	0.2	7.6	0.2	-
35	14.5	4.40	14025	14.9	0.3	0.1	11.1	18.0	0.6	0.3	0.3	5.5	0.3	+
36	13.3	1.29	4131	7.4	0.1	0.1	7.0	11.7	0.3	0.3	0.2	1.6	0.1	-
37	9.3	2.02	9098	715	26.6	0.1	5.7	9.3	0.1	0.1	-	1.6	-	-

Sample	Na(%)	Sc	Fe	Co	Sb	Cs	La	Ce	Eu	Sm	Tb	Hf	Ta	Au
38	17.0	2.50	8161	9.1	16.9	0.9	7.4	12.0	0.8	0.4	0.2	2.6	0.4	+
39	11.3	1.27	3313	5.1	1.1	1.1	6.6	14.6	0.5	0.9	0.2	1.2	0.1	+
40	18.4	1.91	14111	2.7	3.5	0.1	15.0	5.1	0-4	9.8	0.1	1.0	4.3	+
41	14.6	0.66	697	3.8	298	19.6	4.1	-	0-3	0.1	-	4.2	0.4	-
42	17.1	1.07	3611	3.3	355	2.1	5.6	13.8	0-5	1.0	-	-	-	-
43	10.6	1.49	1013	11.6	85.2	6.8	7.1	8.3	0-4	1.0	-	-	-	+
44	7.1	2.92	1803	85.3	696	38.9	1.4	-	0-6	0-5	-	-	-	+
45	15.8	1.11	9261	41.4	388	5.3	38.9	-	0-6	0-2	-	-	-	+
46	11.9	1.45	4883	3.2	2.9	0.1	2.6	8.9	1.2	1-0	-	2.1	0.1	+
47	11.8	1.69	5733	5.8	0.1	0.2	7.2	13.0	0.6	1.0	0.1	1.5	0.2	+
48	12.0	1.60	5897	6.1	0.2	0.3	8.1	13.0	0.7	1.0	0.1	1.4	0.2	-
49	13.9	2.10	7028	12.0	0.1	0.2	7.6	13.7	0.5	0.4	0.2	2.2	0.3	+
50	12.0	1.74	5342	3.9	1.7	0.1	7.4	17.8	0.2	1.0	0.2	2.3	-	+
51	12.6	1.13	3403	1.9	2.0	0.1	5.4	11.9	0.5	0-5	0.1	1.1	-	+

Sample	Na(%)	Sc	Fe	Co	Sb	Cs	La	Ce	Eu	Sm	Tb	Hf	Ta	Au
52	11.9	1.45	4577	1.8	1.4	0.2	6.3	10.1	0.4	0.1	0.2	1.8	0.1	+
53	7.2	1.33	4704	6.2	321	1.7	9.7	16.8	0.2	1.0	-	-	-	+
54	9.6	0.7	1965	2.8	-	0.1	3.8	5.8	0.1	0.3	0.1	0.8	0.1	-
55	4.5	1.33	6485	1.1	48.6	3.2	8.1	9.4	0.5	1.0	0.1	0.7	-	-
56	6.3	1.49	3719	5.5	247	3.6	11.4	-	0.4	0.2	-	-	-	+
57	15.0	2.31	2181	90.9	721	38.0	8.9	-	0.6	0.5	-	-	-	+
58	15.7	2.29	9016	72.2	4.1	0.1	1.0	11.3	10.9	1.0	0.2	2.4	0.1	+
59	14.3	2.01	5925	7.2	0.1	0.2	8.8	16.0	0.5	0.6	0.1	2.0	0.4	+
60	13.0	1.23	3553	2.4	1.0	0.1	6.9	13.7	0.4	0.2	0.2	1.4	-	+
61	12.1	1.67	796	1.8	0.1	0.1	5.6	14.0	0.5	0.4	0.2	2.1	0.1	-
62	13.8	2.06	6387	6.9	13.6	0.1	6.8	10.7	0.2	0.3	0.1	1.9	0.1	+
63	12.9	2.73	10343	12.8	10.7	19.0	8.7	18.5	0.3	1.2	0.2	2.3	0.2	+
64	11.6	1.37	540	3.5	0.1	0.1	7.0	13.7	0.4	0.7	0.2	1.7	-	-
65	10.6	1.37	4051	18.5	2.4	13.9	3.4	-	0.5	0.3	-	-	-	+
66	9.6	1.60	4069	10.1	0.8	0.1	5.9	-	0.6	0.3	0.3	1.2	-	+
67	9.3	2.38	6982	14.5	0.1	0.1	7.7	-	0.8	0.4	-	-	-	-

Sample	Na(%)	Sc	Fe	Ce	Sb	Cs	La	Ce	Eu	Sm	Tb	Hf	Ta	Au
68	20.6	1.20	6973	36.3	12.7	12.7	2.5	-	0.4	0.2	-	-	-	-
69	10.2	6.64	1175	13.4	44.8	0.1	6.4	32.4	2.6	0.4	0.1	5.4	-	+
72	9.6	1.33	3669	1.6	1.4	0.2	5.8	-	0.6	0.2	-	1.4	0.4	+
76	9.0	1.92	5398	10.7	-	0.1	6.8	-	0.6	0.3	0.3	-	0.3	+
77	9.3	1.40	3376	2.1	9.9	0.1	5.3	5.0	0.7	0.3	-	1.5	-	+
78	10.8	1.60	6174	12.7	434	2.2	7.3	-	0.8	0.3	1.3	0.6	-	+
79	8.8	1.09	3515	3.3	46.1	0.1	6.2	2.4	0.4	0.3	0.1	1.9	1.1	+
81	10.9	1.29	3770	4.6	6.5	0.1	6.2	-	0.4	0.3	0.2	2.2	0.8	-
82	11.7	4.06	10709	6.9	-	0.1	9.4	-	0-6	0.4	-	-	-	+
85	12.4	1.86	6567	5.6	0.1	1.8	6.6	-	0-5	0.3	0.2	-	-	-
87	11.0	2.04	6774	6.7	5.5	0.1	4.7	-	0.4	0.2	0.2	2.7	-	-
88	10.6	2.60	22262	16.8	148	4.3	12.9	-	0.7	0.4	0.1	2.7	-	+
89	23.0	3.16	27490	19.9	135	0.7	28.9	-	1.1	0.9	0.3	4.1	0.1	+
91	12.0	2.19	7427	432	22.8	0.1	6.3	-	0.6	0.3	0.1	1.3	2.0	-
92	13.1	2.03	5738	8.4	33.3	0.1	6.2	-	0.4	0.3	0.2	3.3	-	-
95	12.5	0.89	1802	35.6	4085	19.7	4.7	-	0-5	0.1	-	-	-	-

Of the fourteen elements two have already been determined (Na and Fe) from the previous analysis. In particular it can be seen that the Na values from the two methods of analysis differ somewhat per sample. This is brought about by the different statistical errors encountered in the two methods of analysis and bearing in mind the nature of the two methods the discrepancy is an acceptable one. The same applies to the Fe values where the discrepancy is less obvious. The more accurate values for both elements are likely to be those determined from micro-probe analysis where the errors for those quantities are significantly less than for the same quantities determined by neutron activation. Na and Fe are included here for comparative purposes and are not discussed further in this method of analysis.

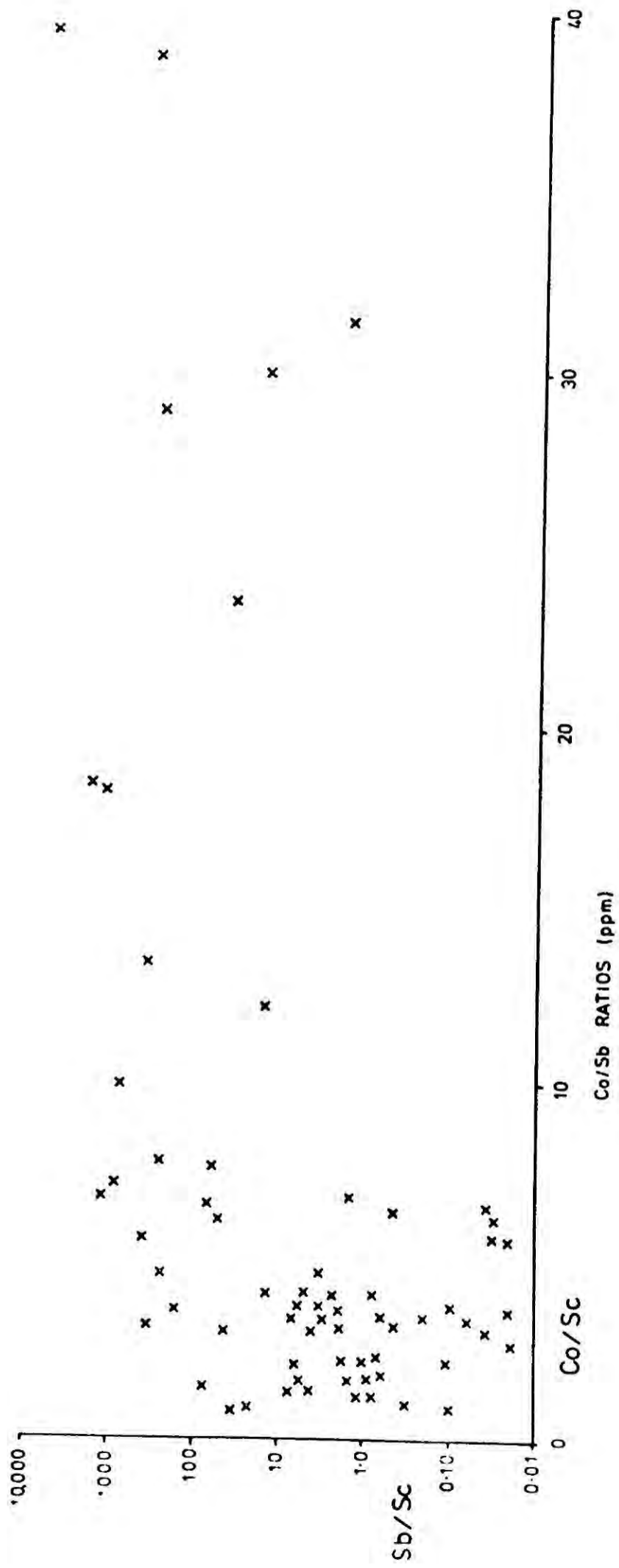
The remaining twelve elements appear in two groups, one containing elements which are detected in all or the majority of samples (Sc, Co, Sb, Cs, La, Eu and Sm) and the other containing elements which are detected sporadically (Ce, Tb, Hf, Ta and Au). In the former group the values range considerably with the greatest variation being in Co and Sb. The Co values have an approximate range of 1 - 700 ppm compared to approximately 1 - 4000 ppm for Sb. In three samples (54, 76 and 82) Sb was not detected. A general correlation between the Co and Sb values can be noted. Careful analysis of the spectra showed such correlations to be real and not to be caused by problems of resolution from peaks of similar energy of the two elements concerned. Variation among the other elements in this group is less pronounced.

The second group contains elements which potentially discriminate simply through absence or presence. There appears to be no significant variation among the values for any given element. The values for Ce are possibly the most interesting ranging from 1 - 32 ppm. Little else can be said. Hf generally appears in quantities greater than 1 ppm while the values for Tb and Ta are less than 1 ppm. These elements may represent the characteristic trace elements of the natural raw materials. The fact that they are not detected in all samples and that at least one element (Ce) has an obvious range in values signifies their potential value as discriminating elements.

In order to minimise possible error caused by flux variation the values for each element were 'standardised' by dividing by the Sc value for that sample (2). This had the added advantage of reducing some of the values to more workable proportions without affecting their significant relationships. Examination of the Sc value shows not to be a relatively consistent element in relation to the weights of the other elements per sample.

A natural assumption at this stage would be to use those elements which appear overall to be potentially the most discriminating (Co and Sb) and attempt to form groupings. Fig. 37 shows the values of Co against those of Sb for each sample plotted on a logarithmic scale. Despite the range of values and possible correlation noted above no clear groupings emerge. Indeed the range is so great in both elements that the variation seems not to be a natural phenomenon caused by differences in the raw material. It would seem reasonable to assume that the range of values given by these two elements is the direct

FIG 37.



result of the use of additives. It may therefore be possible to isolate both Co and Sb from the study as being the result of deliberate actions carried out as part of a technological process. The small quantities present would suggest that they were included as part of a separate compound the exact composition of which remains unknown. Examination of the archaeological context of the samples shows that the varying values for the two elements bear no relation to chronological or geographical factors. Even the highest Sb value recorded here is considerably lower than those recorded by Smith who tabulated the chronological importance of that element as a decolourant in ancient glasses (3). The relatively small quantities of Sb in these glasses by comparison suggest that it was sporadically used as a decolourant in order to neutralise the colouring impurities produced by alkaline raw material. The nature of this material has not been fully established and could well have been derived from a number of sources. It is conceivable that the use of different types of alkaline material within the same workshop could have established the need for varying amounts of Sb for decolouring. The same could apply to the use of Co to effect depth of blueness in colour.

Assuming that the variation in Co and Sb values reflect the deliberate use of agents it now remains to examine other potentially significant elements. The most obvious of these according to the data are the rare earth elements of which La, Ce, Eu and Sm have been detected. These elements above all others should be indicative of characteristic differences between the sources of the natural sand or

sandstone used as raw material. Of the four rare earth elements detected Ce can be singled out as appearing inconsistently throughout the samples. The other three appear in all samples analysed. The least variable of these appears to be La the values of which generally lie within the range of 1 - 10 ppm. In isolation it appears not to be discriminating. In an attempt to ascertain groupings or correlations the sum of the values of Ce, Eu and Sm were plotted against the values of La per sample. La was used here essentially as a standard against which to establish or compare potential information derived from the other three. The graph is shown in fig 38 and indicates that the points clearly fall into two groups defined by the Ce, Eu and Sm values. Seventy-three of the samples are represented on this graph. The remaining two are not plotted. These fall beyond the scope of the graph but nevertheless their values can be associated with the lower of the two groupings shown. All values used were standardised to Sc.

The discriminating axis (Ce, Eu, Sm) shows that within a certain relationship between the three elements there exists a specific grouping factor. It is likely that a single element among them either through broad range of values or simply through presence or absence is causing the groups to be formed. Examination of the values shows this to be true. The discriminating element here is Ce and investigation of the data shows that the samples which comprise the top group without exception contain Ce while in the samples in the lower group Ce is undetected. This is shown in fig 39.

FIG 38.

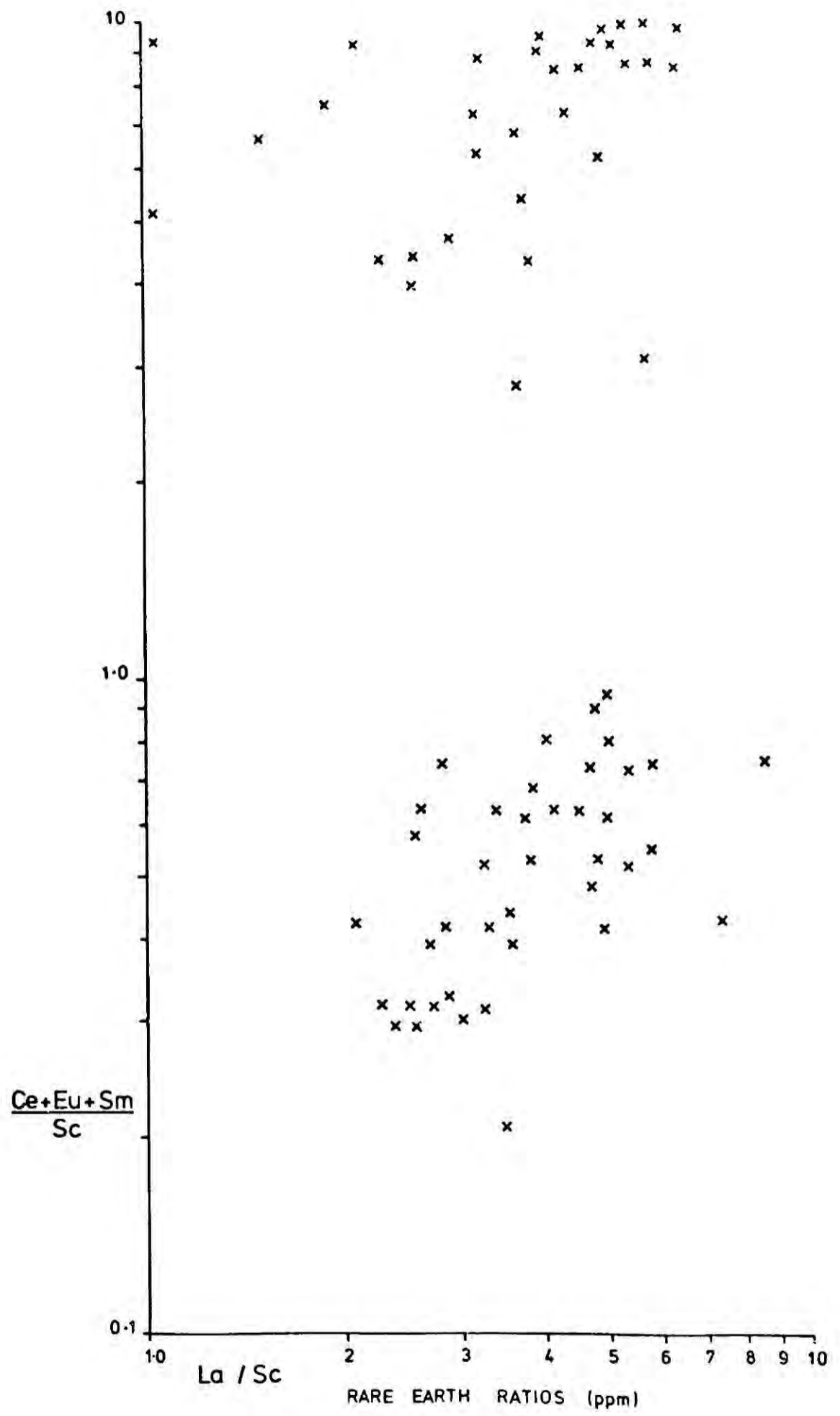
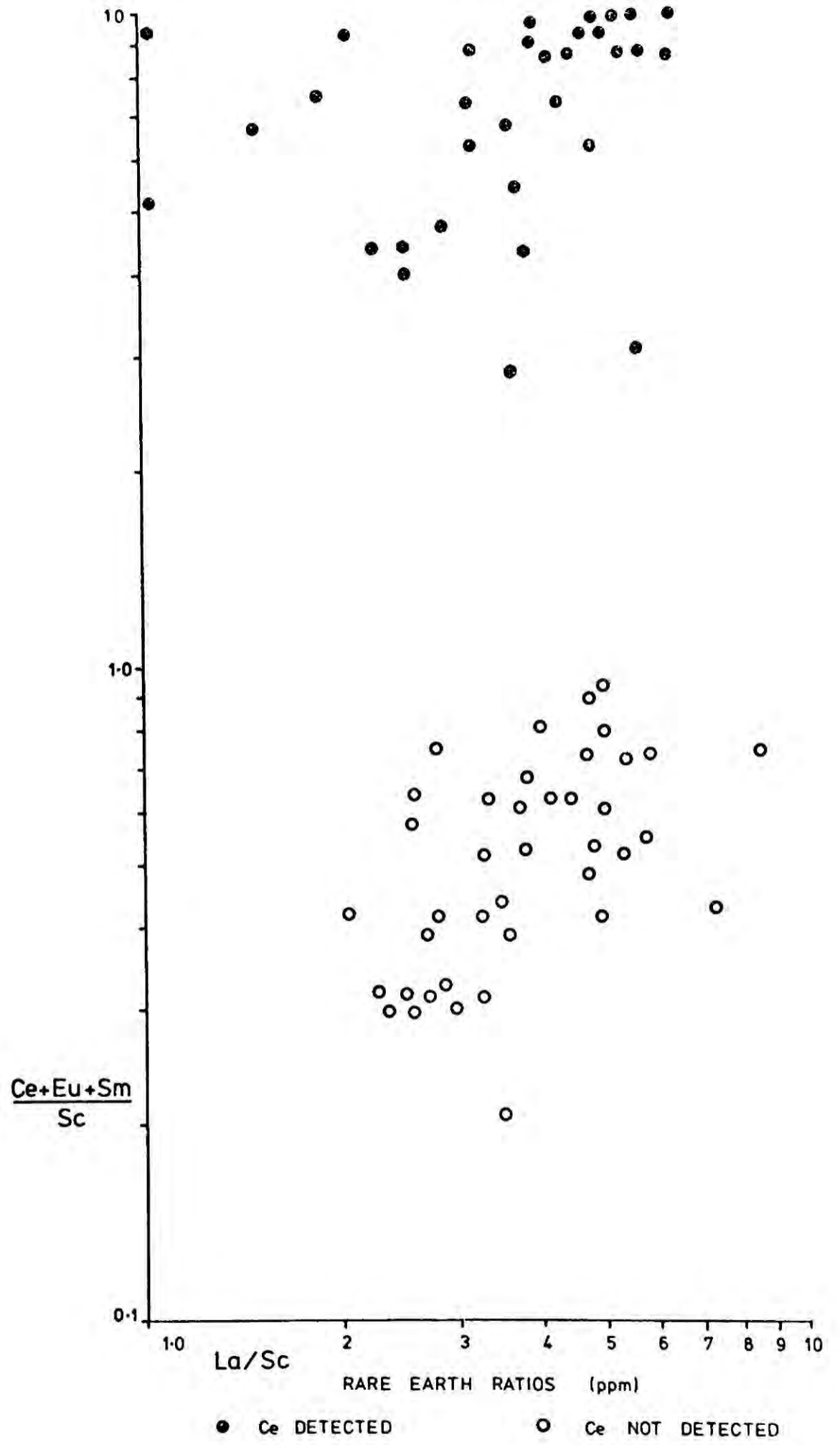


FIG 39.



The relevance of the rare earth Ce in these circumstances is difficult to explain. In geochemical contexts the rare earths tend to exist in defined quantities and proportions depending on the particular material in question. For example the p.p.m. proportions of certain rare earths in a particular material are basically constant although these may differ from the constant proportions of the same rare earths in another material.

Generally speaking differences between established ratios of specific rare earths are diagnostic of either the presence of different materials or of different outcrop sources of the same material. For example the proportion of La : Ce differs between various minerals although remaining essentially constant within each. The following examples taken from tables showing the distribution of elements in the crust of the earth illustrate this (4).

<u>Geological Material</u>	<u>Concentrations (ppm)</u>		<u>Approximate Proportions</u>
	<u>La</u>	<u>Ce</u>	
Sandstone	7.2	15.0	1 : 2
Shales	39	76	1 : 2
Basaltic rock	17	66	1 : 4

If therefore the values from the glass analyses showed that the proportions of these elements were inconsistent throughout the samples this might indicate obvious discrimination. However examination of the proportions of the various rare earths detected indicate relationships which within the limits of experimental error are constant. The rare earths of La and Ce (which show similar chemical characteristics) almost

without exception occur together in sands and often in the proportion of 1 : 2. Analysis of Scottish coastal sands has indicated similar proportions ⁽⁵⁾. The neutron activation analysis of sands from five different locations show the following concentrations and proportions of La and Ce:

<u>Location</u>	<u>Concentrations (ppm)</u>		<u>Approximate Proportions</u>
	<u>La</u>	<u>Ce</u>	
Gullane	6.9	13.8	1 : 2
Glenluce	8.3	16.6	1 : 2
Troon	8.1	12.5	1 : 2
Musselburgh	43.8	24.9	2 : 1
Irvine	7.7	14.1	1 : 2

With the exception of the Musselburgh example the proportions are consistent with those from the glass samples in which both La and Ce were detected. In most cases the absolute concentrations differ although the ratios are essentially constant. The major problem is in explaining exactly why the rare earth Ce is not detected in a large group of the glasses analysed. The La values in all the glasses are relatively consistent and are appropriate to sand or sandstone sources. It can only be suggested that the absence of Ce in certain samples is caused by one of two possible reasons. Firstly it is conceivable that some aspect of the manufacturing process caused the Ce concentrations to be lessened through chemical extraction, and secondly that the low concentrations or even absence of Ce is a phenomenon of certain sands. Bearing in mind the chemical properties of the element the latter seems

more likely. La is an exceptionally stable element and is unlikely to be affected by natural conditions. On the other hand Ce is more volatile and more easily vulnerable to external factors within a natural environment. It is possible that under certain geological or even marine conditions selective leaching of the Ce could have taken place producing sand material which is unusually low in Ce content and undetectable by the method used here. This seems the more likely solution although detailed proof would necessitate the analysis of sands from numerous geographical sources and would require a separate volume of text. It is not appropriate to discuss specific geochemical problems here and this is beyond the scope of the current exercise. Even at this stage it can be seen that the detection of the Ce concentrations is a valid grouping criterion and is brought about by geochemical phenomena. The inference can only be that those glasses which contain Ce are derived from different sands from those glasses in which Ce is not detected. This alone suggests geographical separation of sources. As a result the glasses grouped in fig 39 may represent the existence of two different centres of production.

The next problem is to ascertain the significance of this grouping by either geographical or chronological means. The analysis of major elements and the typological analysis both showed that there were two basic groups of glass in Scandinavia in the first millenium and that an overlap phase between western and eastern glasses was centred approximately around the seventh century. If the two groups defined by Ce are found to be relevant to the same hypotheses then the existence of

two types of glass in Scandinavia must be beyond dispute. The groups defined by Ce are listed below and include the sample number, the date of archaeological context as recorded in the catalogue and the region of discovery.

GROUP I (containing Ce)

3	850 - 900	Uppland
4	800 - 900	Uppland
20	475 - 600	Gotland
30	600 - 650	Gotland
32	550 - 600	Gotland
34	400 - 550/600	Medelpad
35	400 - 550/600	Medelpad
36	Undated	Medelpad
37	400 - 550/600	Medelpad
38	400 - 550/600	Medelpad
39	400 - 500	Medelpad
40	400 - 500	Medelpad
42	400 - 500	Medelpad
43	550 - 800	Närke
46	550 - 800	Södermanland
47	700 - 800	Södermanland
48	700 - 800	Södermanland
49	Undated	Södermanland
50	600 - 700	Södermanland
51	600 - 700	Södermanland

52	600 - 700	Södermanland
53	800 - 1000	Småland
54	900 - 1000	Uppland
55	750 - 850	Uppland
58	450 - 550	Uppland
59	450 - 550	Uppland
60	550 - 800	Uppland
61	550 - 800	Uppland
62	400 - 550/600	Uppland
63	800 - 1000	Uppland
64	200 - 400	Uppland
69	700 - 900	Uppland
77	Undated	Östergötland
79	550 - 800	Södermanland

Total 34.

GROUP II (Without Ce)

1	800 - 1000	Uppland
2	800 - 900	Uppland
5	900 - 950	Uppland
7	800 - 900	Uppland
8	800 - 1000	Uppland
9	200 - 400	Dalsland
11	400 - 475/500	Gotland
14	Undated	Gotland

16	400 - 475/500	Gotland
17	200 - 400	Gotland
18	400 - 475/500	Gotland
19	400 - 475/500	Gotland
21	400 - 475/500	Gotland
23	350 - 475/500	Gotland
24	600 - 650	Gotland
25	400 - 475/500	Gotland
26	475 - 600	Gotland
29	550 - 800	Södermanland
31	550 - 600	Gotland
33	50 - 200	Halland
41	400 - 500	Medelpad
44	700 - 800	Södermanland
45	600 - 800	Södermanland
56	800 - 950	Uppland
57	800 - 900	Uppland
65	600 - 700	Uppland
66	200 - 300	Uppland
67	200 - 400	Uppland
68	50 - 200	Uppland
72	800 - 1000	Uppland
76	Undated	Öland
78	600 - 700	Östergotland
81	400 - 600	Gotland
82	400 - 600	Gotland

85	400 - 600	Gotland
87	Undated	Gotland
88	550 - 800	Gotland
89	550 - 700	Gotland
91	600 - 650	Gotland
92	350 - 400	Gotland
95	350 - 600	Gotland

Total 41.

Although the Ce grouping is a clear one graphically the actual relevance of the glasses to the two groups is less easy to establish. One is confronted with a problem of natural dissimilarity which has to be explained by archaeological reasoning. In most circumstances the situation is reversed with the archaeological problem requiring the study of natural phenomena for its explanation. Fortunately the two methods of analysis preceding this chapter have both suggested solutions and the theories evolved can be applied here.

An understanding of the two groups rests on the assumption that they represent two different sources of natural raw material and hence two different centres of production. For the time being the location of the two centres are unimportant. The analysis of major elements used subtle differences in the silica network structure of the glasses to produce two statistically valid groups. Only a part of the total sample was used. It was found that the glasses from the Gotland and Uppland/Södermanland regions were distinct providing that the glasses

from the Vendel Period were removed from the graph. This inferred that two types of glass existed and that an overlap phase occurred somewhere in the Vendel Period. The typological analysis which was based on completely different evidence confirmed this and furthermore indicated that there was a distribution movement from west to east during the millenium. In general the picture here corresponds to this information. For example it can be no coincidence that all but three of the twenty-four Gotlandic glasses analysed appear in one group and that the west/east shift is also discernable with the Ce group representing the eastern stage of the movement. Total dependence on the archaeological data is on the whole unreliable. The dating ranges for the glasses is often broad and not necessarily accurate and the location of find may not necessarily have any relevance to location of manufacture. Nevertheless the picture is maintained. Group II represents the western and earlier phases of glass into Scandinavia and one would expect this to include items from Dalsland, Halland and the Baltic islands of Gotland and Öland. According to information from the typological analysis these areas received their glass via western routes within the first six or seven centuries. Only one (sample 88) is possibly dated beyond this time. The glasses from Dalsland and Halland (samples 9 and 33 respectively) both dated to the Roman Iron Age represent the earlier phases of introduction and the Gotlandic glasses dating to Migration or early Vendel times reflect the slightly later phase indicated in the typological analysis. However, the explanation of the other glasses in this group is more complex. Seventeen of the forty-one glasses in this group were discovered in the

eastern rather than the western region and eight of these are dated to the latter part of the millennium. Their locations are in Uppland, Södermanland, Medelpad and Östergötland. In all but Uppland the dates are in keeping with the earlier western glasses and a process of trade may be assumed to explain their presence. Twelve of the glasses appear in Uppland. One of these (sample 68) can be dated to the second or third century indicating a remarkably early introduction of glass into the eastern region. Eight of the Uppland glasses are dated to the ninth and tenth centuries. In the typological analysis there was some evidence for the continuation of the western glasses during the later part of the millennium and this seems to be supported here. Examination of the groups determined in the analysis of major elements shows that these particular samples did not appear in the eastern (Uppland/Södermanland) group and that the samples which comprise the groups formed in both methods of analysis are consistent. It is conceivable that these glasses are survivals from an heirloom tradition but as they represent approximately 20% of group II this can be discounted. The only explanation feasible is that of a continuing trade from a western area presumably in the Rhineland.

Group I is less problematic and is comprised of those samples containing Ce. Of the thirty-four glasses, thirty are from the eastern regions of Uppland, Södermanland, Medelpad, Östergötland and Narke. In general the dating of these is consistent with the later part of the millennium and the finds from Uppland and Södermanland tend to belong to the last few centuries. There are exceptions and three of

the Uppland samples are dated to the later part of the Migration Period while one (sample 64) is dated to the end of the Roman Iron Age. In a discussion of the typological elements I suggested that the overlap period which seemed to occur in the sixth or seventh centuries was caused by the commercial output of a relatively new centre possibly based at Helgö. The evidence is in keeping with this and may be used to explain the presence of this earlier glass and indeed the late Roman piece which if dated correctly could have been produced at the earliest stages of development at Helgö towards the end of the fourth century. Seven of the fragments from Medelpad which lies north of Uppland are dated to the Migration Period. This area was in close contact with the Uppland/Södermanland regions at this time and therefore ease of trade from any new centre would not be unexpected. The only real anomaly in the group is the presence of the three glasses from Gotland. All three are dated approximately to the sixth or seventh centuries. This can readily be explained by interplay of trade between the two distribution groups. As I mentioned above one of the major problems is in the actual location of the finds and its relevance to the main area of distribution. Although the regions of Gotland and Uppland/Södermanland may have differed politically at this time the distance between them is relatively small and it would be surprising if there had not been some interplay in trade. The three Gotlandic glasses in this group must be considered exceptional to the main distribution of Ce glasses.

The final analysis certainly confirms the information previously established and thus supports the theory of the west/east distribution.

In some ways the situation is more complicated. It now seems from this latest evidence that the beginning of the overlap phase could perhaps be brought forward into the late sixth century. From the point of view of methodology the combination of three different types of analysis appears to have been successful and have provided a valuable series of complementary investigations. A final discussion on the information gained from these analyses appears in the following chapter.

EXPERIMENTAL NOTES

The samples analysed were the same as those used for the analysis of major elements and in most instances were of approximate mass 100 mg. Larger samples were avoided in order to lessen subsequent problems of geometry and handling (6). In instances where the sample was too large an appropriate mass was cut from it. The samples were cleaned using acetone to dissolve the resin mounts and finally washed in a solution of hydrofluoric acid and distilled water before weighing and dispatch to reactor (A.W.R.E. Aldermaston).

Counting was carried out at Bradford using two detectors (Laben 1024 multi-channel analyser and Hewlett Packard 5401, 4096 multi-channel analyser). Both used a germanium-lithium drifted crystal. Each sample was counted on immediate return from the reactor and then again after a period of approximately twenty-eight days, thus allowing for the more accurate measurement of both short and long-lived isotopes. Both samples and standards were generally counted between one and six inches above the detector window depending on the activity of the sample and/or the time elapsed since return from the reactor. Certain problems arose at this stage with regard to samples with high Sb content the half-life of which (^{124}Sb isotope) is relatively long (approximately 60 days). In these cases the activity was such that the waiting time for counting was considerably longer. In all instances the counting time was adjusted to give an instrument dead-time correction of less than 10%.

The gamma-ray spectra were produced on binary tape and analysed at Bradford through a Hewlett Packard 2116B 16K computer. The spectrum

analysis programme used (SPECT) enabled 48 isotopes to be measured. The standard used (NPSI) was a multi-element standard of crushed pottery prepared in the laboratory. In the glass analysis a large number of elements were detected overall but owing to the presence of interference peaks quantitative estimates were only made on those elements shown in the tables.

CHAPTER EIGHT - REFERENCES AND NOTES

- (1) For obsidian see Wright G.A. Obsidian in Early and Prehistoric Nr. Eastern trade 7500 - 3500 BC, Anthropology Papers No. 37, 1969, Museum of Anthropology, University of Michigan.

For faience see Aspinall A., Warren S.E., Crummet J.G. and Newton R.G. "Neutron Activation of Faience Beads", Archaeometry 14, 1972 pp. 27 - 40.
- (2) Aspinall A., Feather S.W. and Renfrew C. "Neutron Activation Analysis of Ancient Obsidians", Nature 1972 vol 237 No. 5354 p 333f.
- (3) Smith R.W. "The Analytical Study of Glass in Archaeology" Science in Archaeology (ed. Brothwell and Higgs) 1963, p 519f.
- (4) Tables taken from Turekian K.K. in Encyclopedia of Science and Technology 1971.
- (5) I am grateful to Mr. J.G. Crummet and Mr. S.E. Warren for bringing this unpublished data to my attention.
- (6) Warren S.E. "Geometrical factors in the neutron activation analysis of archaeological specimens" Archaeometry 15 1973 pp 115 - 122.

CHAPTER NINE - CONCLUSION

The preceding chapters have been concerned almost totally with problems of method and the results achieved are based entirely on the re-examination and re-interpretation of existing material. The various methods used here to examine Scandinavian glasses have all yielded results which invite a new consideration of present theories. Even the adoption of more rigid and consistent methods of typological description have shown this to be true. Although the task was no more than a logical extension of existing methods it indicates the value of applying broad chronological limits and utilising the numerous featureless fragments which constitute a large proportion of the material. The traditional use of closely-defined Scandinavian chronological periods is shown as being a misleading concept. Although the influxes of glass into Scandinavia noted in chapter six broadly tend to follow these periods the more important evidence is only established by considering the millennium as a whole. The gradual west-east distribution shift is only discernable by looking beyond these closely-dated periods and the determination of the overlap phase can only be appreciated by considering full geographical and chronological factors.

In many ways the conclusions reached in the typological analysis must be considered to be conjectural. The breaking-down of each object into specific typological attributes assumes that such individual elements were relevant at the time of production and that the combinations in which they are catalogued and analysed here are similarly appropriate. Nevertheless the overall picture given by the examination

of the typological elements is consistent. This is shown in both density and distribution. Confirmation of known political and trading situations can be seen in the recognition of influx phases throughout the millennium. The most noticeable of these occurs in the early fifth century with the occupation of the Rhineland houses by Germanic peoples and the introduction of new forms into Scandinavia. The earlier influx (ca. AD 200) reflects the establishment of the original Roman houses in those same regions and marks the start of the first commercial imports through Denmark into Scandinavia. The later influxes are less easy to explain. The final one in the later part of the millennium occurs at a time when the density of items is lower than in earlier years and is perhaps statistically less valid. However, it may mark the introduction of vessels of eastern origin which appear in the Uppland burials and in Britain at this time. The influx in the sixth and early seventh centuries is the most difficult to evaluate. It happens at a time when the period of migrations in N. Europe had effectively ceased and when political activity in the Mediterranean was bringing about changes in the patterns of trade.

Only by considering the millennium as a whole can the full effect of this influx be appreciated. The typological analysis shows without doubt that during the middle years of the millennium the emphasis and direction of trade shifted radically. While in the first five or six centuries the passage of trade was through the west of Scandinavia presumably as a direct result of North Sea trade activity, the impetus in the remaining centuries came from the east. During the interim period of the sixth and seventh centuries distribution occurred from

both sides providing an overlap period in which items from both east and west existed side by side. Objects which can be seen to appear outside their expected regions of distribution are the result of a natural process of trade. The majority of items show an overall picture of a west-east change in trading pattern.

Additional support for this is given by both methods of physical analysis carried out on selected samples. In the analysis of major elements (chapter seven) it was noted that quantifiable differences in chemical structure enabled two groups of glasses to be defined, adding weight to the west-east theory of distribution and further confirming the existence of an overlap phase. Additional confirmation is given by the analysis of trace elements (chapter eight) notably with the presence of the rare earth cerium. Three completely different approaches to the material, each using different criteria and each examining different aspects of the material in question, all point towards the same conclusion. With this weight of evidence there can be little doubt that that phenomena of the distribution shift and the overlap phase are in the most part accurate.

Study of other forms of archaeological evidence tend to suggest that the change in trade pattern was confined almost entirely to glass and not to other artefacts. For example, there is strong evidence to indicate the use of North Sea routes in the Viking Period and this has been shown both in the study of settlement sites (chapter three) and in the discussion of the later glass influxes in chapter six. The chapters devoted to burials and occupation levels (chapters two and three

respectively) show that the presence and distribution of glass was essentially anomalous to that of other artefacts in these regions. One is faced with a situation in which the patterns of glass distribution are behaving in a different manner to those of known settlement and trade. The causes for the shift can only be found within the context of glass itself.

The western influxes in the first half of the millennium are straightforward and can be seen within the general contexts of the North Sea routes. The vessels have parallels elsewhere and are almost certain to have been produced in the Rhineland houses. These trade routes continue, although perhaps in a somewhat lesser capacity, in the later half of the millennium but it seems reasonably clear that glass did not constitute a major part of the commerce. After the seventh century glass in Denmark, the Baltic islands and most of Norway, is rare and it has already been shown (chapter six) that this was not due to differences in burial custom. Instead the density of glasses occurs in the eastern provinces of Sweden particularly in Uppland and Södermanland with a distribution spreading westwards. In my opinion the reasons for this phenomenon must lie in the existence of a glass establishment within those eastern regions. No other solution can satisfactorily explain the distribution. Such an establishment must have created a substantial commercial output at some time in the late sixth or early seventh centuries supplying a broad area of distribution within eastern Sweden. These glasses appear to be characterised by the presence of small concentrations of cerium, a rare earth present in

the natural raw material. It would be incorrect to maintain that every glass from the eastern area contains cerium and that every glass from the western area does not, but the weight of evidence from the seventy-five glasses analysed here shows that with some exceptions this appears to be a sound assumption. Evidence from both typological and analytical methods indicates that although the main influx of cerium glass occurs after the late sixth or early seventh century certain isolated examples appear from contexts dated before that time, the earliest being from the late fourth or early fifth century. Although one could postulate the existence of an external glass establishment producing these wares the rigid distribution within the eastern provinces strongly points towards a local source. The site of the trading settlement at Helgö in Lake Mälär is an obvious candidate. It lies directly in the centre of the distribution area, the earliest date of foundation appears to be the late fourth or early fifth century and the majority of the finds can be dated to a flourishing period in the late sixth or early seventh century. The site has yielded several hundred fragments of glass vessels all of which lie within a settlement area known to be in the most part industrial. Clearly future analysis of the Helgö glass material is crucial for the understanding of the situation.

The methods of physical examination have also offered types of useful information other than those directly associated with the west-east distribution shift. Even at the most superficial level by using a ternary graph for plotting major elements it is clear that the Scandinavian

glasses can be distinguished from other groups of early glasses analysed in the same way. This would seem a useful method for grouping material on broad chronological and geographical levels. During the trace element analysis it was noticed that the concentrations of cobalt and antimony were unusually varied and inconsistent and did not correlate with any known patterns of chronological or geographical distribution. These two elements are known agents for colouring (Co) and decolouring (Sb) and as far as can be seen may reflect the use of various different alkaline sources within the same workshops. One of the most important pieces of information to appear was the susceptibility of these early glasses to examination by this method. The possibility of existing fragments being re-used to produce a better melt would have rendered neutron activation analysis worthless. The fact that in these samples the practice appears not to have been carried out now opens the door for a whole new programme of glass research to take place.

Two of the earlier chapters dealing with glass from burials and occupation layers (chapters two and three respectively) have provided valuable information concerning the supply and use of glass vessels in these periods. Examination of glasses from burials reveals curious anomalies such as complete vessels in cremations and glass fragments laid symbolically within inhumation burials. The whole picture indicates that within the context of burial and therefore presumably within the context of daily life the glass vessel was a prized commodity. The presence of groups of glass and repaired vessels all point towards this. The little evidence from occupation layers suggests

a similar conclusion and also provides additional information with regard to the frequency of glasses on sites affected by the west-east distribution.

Throughout this work I have attempted to establish consistent and in many cases new methods of artefact analysis. The consideration of the social background of the artefact concerned was a prerequisite introduction to the study. Examination of function, distribution and burial significance is fundamental to this task and any analysis undertaken either visually or scientifically must ultimately respond to this background. In criticism of existing works on Scandinavian glass I pointed out three possible shortcomings: firstly that the period under study should be sufficiently broad to illustrate gradual change of typology and distribution, secondly that the fragmentary material which comprises over sixty-five per cent of the corpus should be fully utilised in such a study and thirdly that consistent methods of typological description should be paramount for the proper interpretation of the material. Without these aims it is unlikely that more than a minimum of new information could have evolved from the study.

One of the main problems arising with any examination of a corpus of material is in establishing a viable method of using datable contexts many of which are either too broad to be of value or in some cases even inaccurate. The method used here based on histograms and grouping systems is a new approach and its adoption in this type of problem has an obvious application in other artefact groups. With computer storage and sorting of information and the ability to denote simultaneously in

graphic form such variables as chronology, burial type, geographical distribution and specific typological elements it becomes an invaluable aid in a study of this kind.

The catalogue on which this typological analysis is based is intended to provide as much relevant information as possible concerning the eight hundred or more items included. The location, typological description, find context, associated finds and important references are all included. In retrospect some of the information is superfluous to this study but may doubtless be of value in the future study of Scandinavian glasses from either a similar or different point of view. One of the main aims in producing the catalogue was in ensuring consistency throughout in order that any such future work could be carried out more easily and that additions could be made on the same model.

In many respects the study has been an experiment combining methods of approach from both the scientific and more traditional extremes of archaeology. In this work I hope to have illustrated that the understanding of an artefact group involves a total process of examination including manufacture, deposition, identification, description and, where appropriate, scientific analysis. It is perhaps indicative of the multidisciplinary nature of archaeology that for the full understanding of the glass vessel there is need to call upon such widely differing fields as the anthropology of burials and the geochemical significance of trace elements determined by neutron activation analysis. Each facet of the study produces its own specialist problems and the challenge

of a task such as this is in seeking solutions which lie in disciplines apparently bearing no relation to the subject in question. If there were no problems to be tackled then the exercise would have been fruitless from the start. The more demanding the problems the greater seems the satisfaction at the end.

APPENDIX 1 - PAINTED GLASS

Glass vessels which exhibit painted decoration in Scandinavia appear to divide themselves into two chronologically distinct groups. The first appears within the limits of the Roman Iron Age while the second can be roughly grouped to within the late Vendel and Viking periods. Vessels with this type of decoration comprise a small but significant part of the Scandinavian corpus with complete and fragmentary glasses totalling a minimum of eighteen individual vessels.

The earlier group which is represented by painted animal or circus scenes is a type of decoration which seems restricted to straight sided cups all of which have footrings⁽¹⁾. This type of vessel in both its painted and unpainted form has been the subject of much research and it seems worthwhile to review existing comments on the subject in the light of some additional finds⁽²⁾.

All the Scandinavian examples of these painted cups appear in Denmark and total eleven in number. Of these only four are complete vessels (057, 141, 142 and 176) while the remainder are fragmentary (013, 115, 149, 162, 167, 177, 178). With one exception all these vessels or fragments illustrate painted scenes portraying either animals, humans or plants. The one exception is from Ringe (149) which has been badly mutilated by cremation and on which only traces of paint remain⁽³⁾. The origin of these vessels is undoubtedly the Gallic circus cups illustrated by Chambon and discussed by Kisa and Harden⁽⁴⁾. Originally such vessels were prizes at gladiatorial contests or similar events. In common with most other glasses from

this period in Scandinavia they appear entirely in female burials; a fact which may indicate a different significance set upon them from their original purpose. This is emphasised by the presence of such vessels in pairs or even groups of three among the burial goods (5).

Typological identification has been attempted by Norling-Christensen who included both painted and unpainted cups in his material (6). The Scandinavian unpainted cups total eight in number, six being complete (027, 028, 029, 050, 053 and 139) and two fragmentary (168 and 169). The basis of his investigations lay in the precise determination of rim diameters and height measurements. He found that the ratios of the heights of the vessels to the rim diameters ($\frac{H}{R}$) divided themselves into two groups: those with a $\frac{H}{R}$ ratio which falls between 0.69 - 0.72 and those which fall between 0.75 - 0.88. These he termed the tall and low variants respectively. The examples cited for the tall variants are the vessels from Nordrup (141 and 142) and for the low variant one of the vessels from Himlingøje (057) (7). Scrutiny of this method reveals certain pitfalls. The number of complete vessels readily available from Scandinavia is ten with one or two complete examples from elsewhere. Only two of these form the low variant group. Furthermore, the definition of the ratio categories is only marginal. As the vessels themselves all have height measurements within the range 6.5 - 7.5 cm. and rim diameters between 9.5 - 10.5 cm. the maximum possible $\frac{H}{R}$ ratio is only 0.88 and the minimum 0.69. Consequently a rim diameter or height

variation of only 0.5 cm. would be sufficient to throw any vessel into either group. Smith has discussed the technical factors involved in the manufacture of these vessels and has concluded that they were mould-blown (8). The orientation of microscopic bubbles within the metal in the region of the rim suggests that the upper part of the vessel was splayed while being fashioned. Although the main body would have a consistent form from the blowing, the upper region would be susceptible to minor variation in size and form. The catalogue entries for these vessels invariably mention the uneven and badly formed nature of the rim.

Both these so-called variant types were considered to have had a chronological distinction within the Roman Iron Age (9). Evidence for this was supplied by the bronze fibulae and gold rings which appeared in both the above graves. Those from the Nordrup grave containing the tall variant were stylistically earlier than those from the Himlingøje grave containing the low variant. The conclusion reached was that the tall variant was chronologically earlier than the low variant. A comparison of only two burials based on this dating evidence can hardly merit such a determined conclusion.

A chronology by association on these lines is undoubtedly suspect. However, a much closer chronology for the actual vessel form is more possible. A vessel from Verulanium which was discovered from a context which would allow a dating to between AD 160 - 190 and another example from a Cologne burial dated to the second half of the second century would give a useful terminus post quem of

around AD 150 ⁽¹⁰⁾. Another of the vessels from Himlingøje (050), also unpainted was discovered inside a bronze dish dated to between AD 200 - 250 ⁽¹¹⁾. This burial also contained another glass beaker (051) decorated with applied coloured "snake" trails - a form of decoration attributed to the later Roman Iron Age ⁽¹²⁾. The same burial rather unhelpfully produced a coin of Titus (AD 80). Three more unpainted cups from Borritshoved (027, 028 and 029) appeared in a burial dated by a bronze ladle and sieve to the first part of the late Roman Iron Age ⁽¹³⁾.

The chronological problem may be helped by stylistic factors. The earliest dated burials containing these painted glasses illustrate a technique of painting which achieves an almost three-dimensional effect. This is produced by a subtle choice of colours and shading with thin lines. Vessels of this type are those from Varpelev (176, 177 and 178) and the fragment from Møllegårdsmarken (115), the latter which is from a burial dated by Albrechtsen to between AD 250 - 325 ⁽¹⁴⁾. A different type of painting can be seen on the vessels from Himlingøje (057) and Nordrup (141 and 142) where the animal is no longer seen in perspective, but is heavily coloured and defined by thick black lines. A vessel from Toroslunde (167) shows a more crude depiction particularly in the portrayal of the human figure where the movement is clumsy and awkward ⁽¹⁵⁾. The border of coloured dots or circles which appears below the rim and around the base of the vessel in the Varpelev example, and which appears only below the rim on the Himlingøje and

Nordrup examples, is very uneven and poorly executed on the Torslunde vessel. A parallel for this was found in fragmentary form from Zugmantel, Wiesbaden, Germany and is given a terminus post quem of AD 260⁽¹⁶⁾. A final stylistic phase, visible on the fragments from Stenlille (162) and Nekso (013) shows the painted area extending almost up to the edge of the vessel leaving no room for the usual horizontal row of dots⁽¹⁷⁾. The execution of the painted ornament on these vessels is of the same bold type as that from Himlingøje and Nordrup with the same heavy outline. Stylistically, therefore we may define the Varpelev type and the Stenlille type as being the two extremes of the painted ornament.

Unfortunately the earliest datable find, from Ringe (149) was badly destroyed by cremation but at least it does give evidence for the existence of painted decoration in the late second and early third century. Bearing in mind that the terminus post quem for the actual type of vessel is around AD 150 we can perhaps assume that both painted and unpainted types were contemporaneous. The ultimate stylistic stage can be dated by the associated bronze cauldron in the burial at Stenlille. The Børte class to which this cauldron belongs dates to the later half of the fourth century⁽¹⁸⁾. None of the vessel types appear in burials dated after the end of the Roman Iron Age and we can conclude that they were a product of this period.

The distribution of the painted cups is worthy of detailed study. We have seen that all the eleven Scandinavian examples lie within the Danish islands of Seeland and Funen. There are no examples from Sweden or from Norway. This distribution is hardly surprising for it was in

Denmark that the great imported wealth of the Roman Empire is best concentrated in Scandinavia. The quantity of Roman silver and bronze vessels, particularly from the first two hundred years of the millennium and typified by the rich burial at Hoby, is significantly greater in Denmark than in any other Nordic country (19). The relatively high distribution of painted vessels on Seeland coincides with the relatively dense burial patterns on that island between AD 200 - 400 (20).

Outside Scandinavia further unpainted examples appear from Airlie, Angus, Scotland, discovered with a piece of bone in a stone cist, from Westray, Orkney and from Kingoldrum, Angus (now lost) (21). Painted fragments appear both from Housteads on Hadrians Wall and from Traprain in East Lothian (22). There is a further unpublished piece from the fort at Chesterholne, also on Hadrians Wall. None of these fragments are closely-dated finds although the Housteads fragment illustrates the border of dots below the rim suggesting that it was stylistically not of the latest phase. Finally there is the fragment from Zugmantel mentioned above from a limes fortification. This has been discussed by Fremersdorf in some detail (23).

The earliest type of this form of vessel which appeared in Gaul in the first century AD bore gladiatorial and circus scenes (unpainted) in a mould-blown technique. These vessels show certain affinities to Syrian mould-blown vessels which usually carried Hellenistic motives. There is the possibility that the Gaul vessels were either copies or the result of a direct importation from the East Mediterranean. Other examples of Syrian products appear in the Rhineland and, more important for our present subject, in Denmark. The delicate pair of glass cups with

ground decoration from Stenlille (160 and 161) are of this origin and are dated to the early Roman Iron Age ⁽²⁴⁾. Of all the painted beakers or fragments documented only the fragment from Zugmantel was found within the Roman frontier. The accepted opinion, voiced by Fremersdorf, that the painted vessels were manufactured in the Rhineland carries little weight bearing in mind that among the many thousand examples of glass found at Cologne and other places in the Rhineland and on the Mosel where glass may have been made there is not a single indication of the painted type ⁽²⁵⁾. The distribution of these vessels shows that they are almost exclusively found in outlying places, and this cannot be a statistical accident. This distribution phenomenon can hardly be explained by burial convention or location of manufacture.

Only one explanation is possible to fit the available facts and take into account both the distribution and the varying style of painting. The earliest paintings (Varpelev and Møllegårdsmarken) may not be of Rhenish manufacture but of Eastern import. This is suggested by three factors. Firstly the form of the vessel from Varpelev is significantly different with regard to the foot-ring from the stylistically later vessels. In the latter the foot-ring is applied directly to the base of the vessel, while in the Varpelev example there is an additional 'stem' between the two, approximately the same height as but slightly narrower than the foot-ring itself. Secondly, the depiction of the bird from Varpelev is more akin to an eastern stylistic genre than to a western. The triangular eye and the slender probing toes are features of a stylised creature. The delicate outline and shading and use of coloured dots produce a creature which is not a real representation of a

living bird. Such portrayals are unusual in the Western Empire where all animals are reflected artistically in a form as close to the living animal as possible. Furthermore, I have shown below the importance of the bird form in eastern art. Thirdly, the method of manufacture needed for fired painting is difficult to conceive in the Western Empire in the early part of the Roman Iron Age. The presence of the inscription "D.V.B.P." (Da Vinum Bonum Pie) does however indicate production for Roman clientel. A similar inscription but in Greek can be seen on the "Skyphos" bowl also from the gravefield from Varpelev (180) and has a parallel in the Museo Civico, Adria, Italy dated to the first century AD (26). One is led to believe that the vessel was manufactured with a specific market in mind, perhaps by a Syrian glass maker who kept alive the art of the east in an outpost population. Although the vessel is probably the product of Syrian craftsmanship, the place of manufacture may not necessarily be eastern. The vessel may be the result of immigrant Syrian glassmakers working in the west. In this case the Varpelev painted cup would be the result of one of the earlier immigrants, the majority of whom arrived in the late second or early third century.

The stylistic stages of the Nordrup and Himlingøje types can in no way be considered a degenerate stage of this type of painting. The general layout, form of decoration and use of paint is too different. The whole atmosphere of the decoration is less free and the movement of the animals more wooden. These vessels must represent a change of craftsmanship although not a change of inspiration. In this respect the distribution can be mentioned once more. The almost total distribution on or outside the Roman limes must signify the availability of a market

which was readily acceptable to this form of product. The occurrence of the vessels at garrison locations, notably in Northumberland and at Zugmantel point to their popularity with either the Roman personnel or the barbarian elite. The strong distribution outside the limes tends to suggest the latter. Only this theory could explain their relative density in Denmark and Scotland. Distribution is a very dangerous factor to pursue too closely. Nevertheless one is left with the feeling that these vessels were intended for barbarian use and were perhaps even given as an award for some particular service.

The animal forms on the Nordrup and Himlingøje vessels are not altogether those one might expect to find in terms of realism and finesse. They are certainly more in keeping with a Roman tradition which portrayed animal form as a true reflection of a living beast than the later Germanic animal forms. Nevertheless movement in this direction can be seen in the leopard from Himlingøje whose feet are out of proportion to the rest of the body. It is out of the question to suppose that these vessels were manufactured by the Germanic laeti, but one must certainly admit that these heavy and forceful beasts are more closely allied to the late fourth century Germanic animal ornament depicted on the metal-work from the cemeteries at Tournai, Vermand and Dorchester-on-Thames than they are to the art of the Varpelev vessel. The fact that these vessels may have been intended specifically for the barbarians may have caused their decoration to be portrayed in a manner more acceptable to those peoples whose tastes as we know from their early metalwork and pottery lay in a curious combination of the culture of their superiors and their own humbler background. It is unlikely that

the manufacture of these vessels was carried out by Syrian hands and it is more likely to have been undertaken by western glassmakers who studied the principle and adapted it to suit the market they had in mind. The appearance of these vessels in that their general dating places them within the last part of the Roman Iron Age surely offers a useful coincidence with the presence of Germanic mercenary forces within the Roman army at approximately the same period.

The later group of vessels showing painted decoration cannot be dealt with in the same manner. The types of vessel and decoration are all dissimilar, and the countries of manufacture different. There are seven examples of the later painted glass in Scandinavia (489, 596, 613, 661, 664, 690 and 799), all of them fragmentary and only exhibiting the slightest traces of painted decoration. They appear without exception from Swedish soil. Because of their fragmentary nature they cannot be discussed in terms of decorative or stylistic qualities and in most cases discussion is restricted to the actual phenomenon of painted glass at this time.

They can, however, be divided into two groups; those which show traces of gold foil decoration and those with other colours. In the former group there are three fragments, two from Ekerö parish, Helgö (569 and 613) and one from Toroslunda parish, Öland (799)⁽²⁷⁾. There is a fourth example from Gamla Uppsala parish (Valsgårde) which was excavated almost forty years ago and now lies in the Uppsala Universitets Historiska Museum. This unpublished fragment was unavailable and is not included in the catalogue. It only remains to say that the appearance of this fragment of gold glass within the dating spectrum of the

Valsgårde burials would have been extremely important for this study.

The first fragment from Helgö (596) has already been the subject of a detailed study⁽²⁸⁾. The fragment itself is from a blue vessel showing only the rim form and a minor part of the decoration. This decoration consists of small triangles the points of which terminate in rhombs. A horizontal band of these shapes is set below the rim and was originally covered with gold foil, traces of which still survive. The stratigraphy from Helgö is not helpful in dating and places the vessel between the years AD 350 - 800⁽²⁹⁾. Glass with gold foil appears on the continent as early as the Roman Iron Age. Technically this foil can be applied in either of two ways. The more common Roman method was to apply the foil to the metal and then to cover it with a protective layer of thin glass. In the other method the gold foil is applied without the protection. Instructions for the proper use of gold foil on glass are recorded by Heraclius in De coloribus et artibus romanorum⁽³⁰⁾. Both methods can be seen in the use of gold foil decoration on glass vessels from the catacombs of Rome where the gold is used to depict Christian symbols⁽³¹⁾. There are several well-known examples of gold glasses from the late Empire, notably the vessel from Köln-Braunsfeld⁽³²⁾. All this tends to suggest that the Helgö fragment belongs to the late Roman period - that is to say, to the earliest years of the settlement at Helgö. However, there are other factors to bear in mind. The technical knowledge for the use of gold on glass had evolved as early as the third century B.C. and can be seen on the Gordion bowl⁽³³⁾. The later Roman wares illustrate the continuing tradition; a tradition whose tangible remains vanish together with the years of Roman

rule and which seemingly emerge again in the Islamic wares towards the end of the first millennium A.D. The lack of evidence for gold glass between the fourth and ninth centuries does not necessarily imply that such glasses were not produced during those years. Consequently the Helgö fragments may well belong to a persisting tradition of glass manufacture which has hitherto not been found archaeologically.

Evidence for this is fortunately available in a recently discovered fragment of glass from Paderborn, Westphalia which shows a similar type of gold foil decoration to the Helgö fragment. This can be dated by the stratigraphy of the site to the year of AD 778 ⁽³⁴⁾. Consequently one is led to believe that gold foil decoration may indeed be a product of the Migration and Vendel periods.

At this point one can profitably turn to similar decorative forms on other objects. The similarity of certain decorations on glass and pottery has already been pointed out by Lamm, and this seems a justifiable course to follow ⁽³⁵⁾. The same type of decoration on the Helgö fragment can be seen on the "Frisian" type of pottery vessels discussed by Selling ⁽³⁶⁾. Here the decoration is with tin foil and not gold, but the form of decoration is almost identical. The presence of Christian symbols on these vessels has caused Selling to attribute them to some type of liturgical function and their distribution, which is confined to sites the majority of which have fully documented missionary activity, supports this ⁽³⁷⁾. Furthermore, she maintains that these vessels are all so similar in form and type of decoration that they were probably manufactured at the same place and cites the monastery at Lorsch

(founded 764) as being a possibility. Her reasons for this lie in the presence of the same decorative shapes painted on the wall plaster within the monastery (38). This belief in no way proves that Helgo was a Christian site or that the type of decoration necessarily denotes a strong Christian commitment in places where it appears in heathen lands. One of the Helgö burials produced fragments of a Frisian vessel together with a painted oath stone and thus provides evidence for parallel cults (39).

The Christian significance cannot be over-emphasised. There is evidence of glass chalices in Carolingian times in the Admonitio Synodalis (mid ninth century) where they are clearly mentioned in a religious connection. Furthermore the glass vessels donated by Ausegeis, Abbot of Fontanelle (823 - 833) and described as being "Cuppas Vitreas Auro Ornatas Duas" tend to strengthen this opinion (40).

An exact dating for the Helgö fragment is difficult to assess. Similar types of decorations appear on a shield boss from Morken, Cologne dated by a coin of Tiberius Constantinius (578 - 582) (41). This find together with the Paderborn fragment and the occurrence of the Frisian vessels shows that the technique of applying gold foil both to glass and other items was certainly alive in the Vendel and Viking periods. One cannot assume that the later appearances of gold foil on glass, notably on the Islamic products and on the glass decorative cubes from the court of Charlemagne is totally due to a Carolingian renaissance in Europe (42). The evidence now shows that there was a persisting tradition from the late Roman era onwards to which this Helgö fragment must belong

on account of the typology of the decoration.

The other fragment from Helgö (613) can be introduced at this point. This fragment from the body of a vessel shows a decoration consisting of pointed arcades made of narrow gold bands. Much of the gold foil has been lost and there is also no protective layer of thin glass. The form of decoration is unique, although similar usage of straight lines and cross points appears in the ground and incised decoration on glass vessels from the late Roman and early Migration period. Here can be cited the beaker from Foldvik, Norway (317) where the decoration consists of bands of incised lines set both horizontally and vertically and intercepting in 'Y' shapes⁽⁴³⁾. Perhaps we can associate the Helgö fragment to this general form of decoration. Apart from this there is little else on which to comment.

The final fragment of gold glass from Scandinavia appears in an unpublished cremation burial from Torslunda parish, Öland (799). The fragment itself is badly distorted by fire but the gold foil is nevertheless still evident. There is no indication of pattern and it appears as though the foil has been applied in one piece to cover a large area. Once again there is no evidence of a protective layer of thin glass. The majority of the other finds in the burial are too mutilated to provide useful dating although a fragment of glass from another vessel offers a broad solution. This fragment, from a light green vessel, shows indications of thick applied trails in the same manner and orientation as the trails on the common "Snartemo" type of beaker. Snartemo beakers are vessels typical of the Migration period and this thus suggests a Migration

period date for the grave from Toroslunda.

These three isolated examples of gold glass seem to indicate that the technique of applying gold foil to a glass vessel did not disappear with the end of Roman domination. All three can be argued to fit within the Migration and Vendel periods and together with the fourth fragment from Valsgarde provide convincing evidence for the survival of this art.

The remaining fragments of painted glass appear from Järfälla parish, Barkaby (661 and 664), from Birka grave 124 (489) and from a burial at Norra Botkyrka parish (690). All these were cremation burials which destroyed most of the evidence for the vessel form and the extent of the decoration.

The two fragments from Järfälla parish appear from a burial which contained the remains of possibly six different vessels⁽⁴⁴⁾. One fragment (664) merely shows a dark brown spot of paint applied on the outside of the vessel. The extent and type of decoration remain unknown. However, the other fragment (661), which Lamm assigns to a group of cylindrical vessels, shows part of the head of a bird and traces of a Coptic inscription⁽⁴⁵⁾. Here the painting is applied on both sides of the vessel with a technique known as lustre-painting thought to have originated in Egypt. Lamm regards both form and decoration as belonging to Egyptian products of the late ninth century. The symbol of the bird is a common eastern theme and can be paralleled by a vessel in the Cairo Museum which shows a row of birds formed by pinching set around the side of the vessel⁽⁴⁶⁾. The form of the vessel itself although admittedly difficult to identify from the fragments is probably similar to the cup from Birka grave 542 (506)

which incidentally also portrays two (rather crudely) incised bird forms (47). This cup is also often quoted as bearing traces of painted decoration, but a detailed study reveals that the traces of "paint" which lie only on the exterior of the vessel consist of small patches of a greyish white deposit which is more likely to be corrosion from another object in the burial (48). Furthermore there seems to be no parallel for incised decoration and paint on the same vessel.

There is little doubt that the painted bird fragment from Järfälla is of eastern origin. This is supported by the nature of some of the other glass fragments in the burial which Lamm associates with various cups and a lamp with eastern parallels. The fragmentary nature of the material has caused Holmquist to object to such positive identification but Lamm's theory can be supported in other ways. Reviewing the situation from a negative point of view, one could profitably argue that the translucent greens and deep magenta of the Järfälla fragments have no parallels on this side of the Mediterranean (49). Furthermore, the indications of a vessel with a handle, a phenomenon totally unknown at this time in western Europe, once more supports the theory of Eastern manufacture.

The bird fragment is easily placed, and painted birds on glass vessels are known from Samarra (50). These vessels are dated to the end of the ninth century and are considered to be of the last phase in the evolution of Sasanian painting - an art which may have originally been derived from textiles (51). There is an interesting passage from

Nasir al-Din al Tusi's (d. 1256) Tansuq-nama relating to a large output of glass vessels which the author lamented no longer took place in his day (52). There is mention of beautiful glasses which were cut on a wheel on onyx and decorated with ornamental devices and figural representations. There is no specific mention of bird forms, but this seems to be such a common form that they may have been included under 'figural representations'. A vessel of the type mentioned above was discovered in the treasure of Marwan II, the last Caliph of Damascus (744 - 750) which illustrates a man kneeling aiming his bow at a lion (53). This depiction immediately recalls the painted Danish animal cups from the Roman Iron Age some several centuries earlier which show similar scenes of man and beast in action. I suggested above that these Danish cups may have been eastern in origin perhaps represented by the bird on the cup from Varpelev. To enforce this opinion a fragment of glass, discovered from the monastery of Apa Jeremias at Seqqara, also depicts this curious bird decoration, and provides us with a useful indication of continuity in that the main period of the monastery dates to around the year AD 500 (54).

Little can be said of the remaining two fragments. The fragment from Birka grave 124 (489) shows a narrow line painted in brown on one side of the vessel (55). The form of the vessel cannot be reconstructed. The same burial also contained the burnt remains of at least two other vessels together with a fragment of window glass. The burial is dated to the Viking Period. It is usually assumed that painted glass which appears in the Viking Period is a phenomenon of the East and its appearance therefore is representative of imported wares, a fact which

is argued on the basis of a large number of eastern objects within the Birka graveyard not to mention the thousands of Arabic coins found in Scandinavia. There is no real evidence to suggest otherwise, and unless complete objects with known western forms also showing painted decoration are discovered, we are forced to rely upon these obscure fragments for discussion.

A useful addition in this respect is the fragment of painted glass from Norra Botkyrka parish (690). This is a fragment of filigree glass showing traces of red paint (56). Filigree glass is a separate problem and is discussed in detail in appendix 2. To avoid repetition it suffices to say that the dating of filigree glass seems to span the Vendel and Viking periods. The burial at Norra Botkyrka is more helpful in that it is dated by the excavator to between AD 700 - 900. This could conceivably infer the presence of painted glass in Scandinavia in the pre-Islamic period, or more to the point, in the years when trade contact with the East was negligible. Furthermore, the distribution of filigree glass is with one exception restricted to Scandinavia and Britain - a fact which at least suggests that the place of manufacture lay to the west rather than to the east of the Mediterranean. Bearing this in mind, it may perhaps be shown that painted glass was manufactured in western Europe, a conclusion for which the Norra Botkyrka fragment is the sole evidence.

There were clearly persisting occurrences of painted vessels in eastern and western Europe. It is unfortunate that the evidence available is both scanty and mutilated, but nevertheless the presence of gold foil glass and painted glass in the years between the Roman

and Islamic periods must certainly be counted as evidence for a continuing tradition.

APPENDIX 1 - REFERENCES AND NOTES

- (1) This type of vessel is commonly referred to by Ekholm and others as either a 'cylindrical cup' or 'cylindrical beaker'. I have used my own modified definition according to criteria established in Chapter 5.
- (2) Among others, H.J. Eggers, "Das Körpergrab von Woldegk, Mecklenburg-Strelitz", Hammaburg 3, 1949, pp.230 - 237. Also E. Kruger, "Ein graviertes Glasbecher mit Darstellung eines Wagenkämpfers aus Trier", Bonner Jahrb. 118, 1909, pp. 353 - 369; and E. Schuldt, "Das spätromische Grab von Jesendorf, Kr. Wismar", Hammaburg 3, 1949, pp.225 - 230.
- (3) E. Albrechtsen, Fynske Jernaldergrave III, 1969, p. 87 and p. 53:48.
- (4) R. Chambon, L'Histoire de la Verrerie en Belgique, 1955. A. Kisa, Das Glas im Altertum, 1908, pp.821 - 832 (O. Almgren, "Die Funde antiker Gläser in Skandinavien", p. 903 ff.). D.B. Harden, "The Glass, Camulodunum", Report of the research Committee of the Society of Antiquaries of London, Vol. XIV, p. 299f.
- (5) Here can be cited the three Varpelev vessels (176 - 178), the three vessels from Borritshoved (027 - 029) and the pair of vessels from Nordup (141 - 142).
- (6) H. Norling-Christensen, "Gravfund fra Borritshoved med Romerske Glas og Bronzekar", KUML, 1952, pp.87 - 90.

- (7) P. Petersen, "Gravpladsen fra den Aeldre Jernalder paa Nordup Mark ved Ringsted", Nordiske Fortidsminder, 1880, pp. 1 - 14. S. Muller, "Udsigt over Oldtidsudgravninger", Aarbøger for nordisk Oldkyndighed og Historie 1837, pp. 161 - 224.
- (8) R.W. Smith, "A Unique Occurrence of Roman Glass at Zugmantel", Saalburg Jahrbuch, XIV, 1955, pp. 60 - 64.
- (9) H. Norling-Christensen, Op. cit., 1952 pp. 87 - 90.
- (10) M. Wheeler, Verulanium, p. 187 and fig. 29:24. Poppelreuter, "Die romischen Gräber Kolns", Bonner Jahrbucher, 114 - 115, Plate XXIII.
- (11) H. Norling-Christensen, "Jaernaldergravpladsen ved Himlingøje", Nationalmuseets Arbejdsmark, 1951, pp. 39 - 46.
- (12) G. Ekholm, "Westeuropäische Gläser in Skandinavien während der späten kaiser- und der frühen Merowingerzeit", Acta Archaeologica, 29, 1958, pp. 23 - 28.
- (13) H. Norling-Christensen, Op. cit., 1952, pp. 84 - 92.
- (14) E. Albrechtsen, Fynske Jernaldergrave, IV, 1971, p. 115:1304 and figs. 271a:2 and 140g.
- (15) C. Engelhardt, "Romerske Statuetter og andre Kunstgjenstande fra den tidlige nordiske Jernalder", Aarbøger for nordisk oldkyndighed og Historie, 1871, p. 441.
- (16) R.W. Smith, Op. cit., 1955.

- (17) H. Norling-Christensen, "Vestlandskedler og Malede Glas", KULM 1953, pp. 47 - 60.
G. Ekholm, "Bornholms fynd av romerska importvaror", Bornhoms Samlingar, XXV, 1937, p. 340 and p. 342 fig. 9.
- (18) H. Norling-Christensen, *Op. cit.*, 1953, p. 55 ff.
- (19) G. Ekholm, Handelforbindelser mellan Skandinavien och Romerska riket, 1961.
- (20) J. Brondsted, Danmarks Oldtid, III, 1940, fig. 166.
- (21) All three finds are listed by J. Curle, "Objects of Roman and Provincial Origin II", Proceedings of the Society of Antiquaries of Scotland, LXVI, 1932, pp. 290 - 296. The Airlie, Angus fragment is illustrated on p. 292, fig. 3.
- (22) J. Curle, Op. cit., 1932, p. 293 f. and fig. 5:2 (Traprain fragment) and p. 293 f. and fig. 5:2 (Housteads fragment). The Housteads fragment is also discussed by W.A. Thorpe, English Glass, 1935, p. 39 f.
- (23) F. Fremersdorf, Figurlich geschliffene Gläser, Eine Kolner Werkstatt des 3. Jahrhunderts, 1951, p. 17 and note I.
- (24) H. Norling-Christensen, "Stenlille Fundet", Acta Archaeologica, XI, 1940.
- (25) F. Fremersdorf, *Op. cit.* 1951.
- (26) J. Brondsted, *Op. cit.*, 1940, p. 196.

- (27) W. Holmqvist and B. Arrenhius, Excavations at Helgö II, 1964, p. 256 and fig. 120. A. Lundstrom, "Cuppa Vitrea Auro Ornata", Antikvariskt Arkiv 40, 1971, pp. 52 - 68 and fig. 1.

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- (36) D. Selling, Wikingerzeitliche und frühmittelalterliche Keramik
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- (37) D. Selling, 'Problem kring vikingatiden keramikkanor",
Fornvännen 1951. Also D. Elmers, 'Zum Trinkgeschirr der
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- (38) F. von Juraschek, "Die Rauten der Kongishalle in Lorsch",
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- (40) J. Braun. Das christliche Altargerat, Munich 1930, p. 39.
- (41) O. Dopperfeld and R. Pirling, Frankische Fursten im Rheinland,
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- (42) C.J. Lamm, Op. cit., 1941.
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- (43) B. Hougen, "Grav og gravplass i Ostfold og Vestfold", Videnskabs-
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- (44) C.J. Lamm, Op. cit., 1941, pp. 7 - 12.
- (45) C.J. Lamm, Op.cit., 1941, p. 10f.
- (46) Illustrated by Lamm, Op. cit., 1941, plate II.
- (47) H. Arberman, Birka, Vol. I, 1943, plates 194:Ia and 194:Ib.
- (48) C.J. Lamm, Op. cit., 1941, p. 12.

- (49) W. Holmqvist, *Op. cit.*, 1964, p. 250.
- (50) E. Herzfeld, Die Mälereien von Samarra, 1927, plates 48 and 49.
- (51) C.J. Lamm, Cotton in Mediaeval Textiles of the Near East, 1937.
- (52) P. Kahle, "Die Shätze der Fatimiden", Zeitschrift der Deutschen Morgen-landischen Gesellschaft, LXXXIX, 1935, pp. 341 f. and note 2.
- (53) In the history of Sinbad a similar cup is described as a gift from Harun al-Rashid to the King of Ceylon.
- (54) J.E. Quibell, Excavations at Saggara, IV, 1912, plates VIII:I - VIII:4.
- (55) H. Arbman, *Op. cit.*, 1943, p. 55f.
- (56) A. Bennett, "Gravfält och fynd fran jarnaldern", Fornvännen 1972, pp. 239 0 253 and fig. 6b.

APPENDIX 2 - FILIGREE GLASS

The number of vessels or fragments exhibiting filigree rod decoration totals nineteen. In Scandinavia this type of glass find has been restricted to Sweden (thirteen examples) and Norway (six examples). Only three of the vessels are complete and are from Hopperstad, Norway (334), Birka grave 649, Sweden (516) and Gamla Uppsala, Sweden (618). Of the remainder only five sets of fragments, all from Helgö, Sweden (547 - 551), can be partially reconstructed with any degree of success. These eight examples form the only basis for discussion regarding the form of the vessels and the overall decorative use of the filigree rod.

The two complete jars from Hopperstad and Birka 649 are remarkably similar ⁽¹⁾. Although different in size, they are proportionally identical. Both use the decoration of the vertical filigree rod and both have a dark blue rim. In terms of quality they are both extremely well-fashioned vessels although the Hopperstad rods are less carefully applied. The use of a secondary decorative technique, namely the horizontal applied or marvered opaque yellow trails occurs on both, although on the Hopperstad vessel this is restricted to the area of the neck. The Birka example shows marvered horizontal trails on the main body of the vessel directly between the filigree rods. On both vessels the filigree rods radiate from a common point at the base and contain filigree spirals in opaque yellow.

A similar form of this type of vessel may be reconstructed from a set of fragments from Helgö (551) ⁽²⁾. The fundamental difference in form from the two complete jars lies in the area of the neck and

shoulder. It is exactly at these points that the reconstruction is at its most hypothetical and therefore a reasonably close similarity in form cannot be ruled out. In terms of decoration, however, the application of the filigree rods is slightly different. Indeed, the rods are vertical and terminate at the shoulder but only six rods are used and are applied with almost geometric precision. The neck of the vessel shows the use of horizontally applied opaque yellow trails. A major difference however lies in the colour of the vessel. Both the Hopperstad and Birka examples can be described as either light blue or light green while the Helgö vessel is an opaque dark red. The sections of the fragments show a layering effect of light and dark red reminiscent of Arwidsson's discussion of a similar effect on one of the claw beakers from Gamla Uppsala (617) (3). The most fundamental difference, however, lies in the formation of the filigree rods themselves. While the two complete vessels show the traditional spiral within the rod, the Helgö fragments display a spiral seemingly applied to the outside of the rod and standing in relief. Furthermore, the spiral seems only to be applied across the facing side of the rod, and the points at which the spiral touches the surface of the vessel are clearly indicated by a slight blurring of the colours on either side.

The complete bowl from Gamla Uppsala (618) is perhaps the best known example of filigree glass (4). Here the vertical filigree rods radiate from a common point of origin at the base and terminate against a horizontal band of four closely set rods below the rim. The rim itself is dark green and the filigree spirals are of opaque yellow. Again one must mention the use of horizontal marvered opaque yellow

trails set between the rim and the filigree decoration. Fragments of a similar bowl may have been found at Helgö (547)⁽⁵⁾. These show a vessel with the same design of vertical and horizontal rods. The colouring, the use of the folded rim and the similarity of decoration all suggest a common origin for the two vessels. Noticeable, however, is the lack of marvered or applied decoration on the Helgö fragments.

The Helgö material yielded two more possible bowl forms. One (549), apparently proportionally similar to the Gamla Uppsala vessel (618) shows vertically applied rods terminating against several horizontally applied marvered trails⁽⁶⁾. The basic design is essentially more simple yet the use of colouring makes the vessel quite different from all other examples. Here the filigree rods contain alternate opaque white and opaque yellow spirals and the horizontal marvering is carried out using the same alternating colours.

Fragments of a slightly deeper bowl (548) were also discovered at Helgö⁽⁷⁾. Here the vertical rods terminate against a band of applied trails set horizontally below the rim. Both spirals and trails are in opaque white. Once again the rim is folded.

The final set of fragments susceptible to reconstruction seem to represent some form of beaker and is the only one of its type from Scandinavia (550)⁽⁸⁾. Both rim and base fragments are missing, but the surviving evidence suggests a vessel of conical form. The vertical filigree rods contain opaque yellow spirals and terminate approximately two thirds of the way up the vessel against a horizontal series of bands of applied opaque yellow trails.

Little can be said of the remaining fragments from Scandinavia, although to some extent they can be classified according to the colours of the glass spirals within the rods themselves. Fragments containing opaque yellow spirals appear from Brevikstranden, Norway (307), Kaupang, Norway (356 - 357), Norra Botkyrka, Sweden (691) and from Grasgård (Eketorp), Sweden (779). Those with opaque white spirals appear from Kaupang, Norway (358 - 359), Birka grave 370, Sweden (494) and Birka (Black Earth) (538). A fragment from Helgö, Sweden (615) shows rods which contain both blue and dark red spirals. The final fragment, from Norra Botkyrka, Sweden (690) contains opaque red spirals.

It has already been seen with regard to the complete and partially reconstructed vessels that considerable use is made of a secondary decorative element, namely the horizontal marvered or applied trails. This is also evident on some of the fragments such as those from Helgo (357, 615) and Norra Botkyrka (691). Details of the vessels and fragments can be seen in the table below.

<u>Cat. number</u>	<u>Form</u>	<u>Colour of spirals</u>			<u>Marvering/ /Applied trails</u>
		<u>Yell.</u>	<u>White</u>	<u>Other</u>	
307	-	X	-	-	-
334	Jar	X	-	-	X
356	-	X	-	-	-
357	-	X	-	-	X
358	-	-	X	-	-
359	-	-	X	-	-
494	-	-	X	-	-
516	Jar	-	X	X	X

<u>Cat. number</u>	<u>Form</u>	<u>Colour of spirals</u>			<u>Marvering/ Applied trails</u>
		<u>Yell.</u>	<u>White</u>	<u>Other</u>	
538	-	-	X	-	-
547	Bowl	X	-	-	-
548	Bowl	X	-	-	X
549	Bowl	X	X	-	X
550	Beaker	X	-	-	X
551	Jar	X	-	-	X
615	-	-	-	X	X
618	Bowl	X	-	-	X
690	-	-	-	X	-
691	-	X	-	-	X
779	-	X	-	-	-

Clearly a fragment can only be truly classified as being from a filigree vessel if there are indications of filigree rod decoration. However, the use of marvered and applied decoration on seven out of the eight complete or partially reconstructed examples tends to suggest that this combination may have been a standard form of decoration. It only appears on a few other types of vessel, notably on the claw beaker, some of the later Migration Period vessels and occasionally on the cone beakers of the Viking Period. Thus there are many fragments exhibiting this type of decoration which may belong to the filigree group. Among these are several from both Helgö and Kaupang as well as a fragment from Birka grave 557 (509) and a fragment from Husby (Ingjaldshogen), Sweden (645)⁽⁹⁾.

Few of these examples are from closely-dated archaeological contexts. The Gamla Uppsala vessel (618) is from a burial dated to the

mid-eighth century. The jar from Hopperstad (334) was found in a late ninth or early tenth century burial, and the fragment from Brevikstranden (307) appeared in a burial dated to the eighth century ⁽¹⁰⁾. Of the remainder, the two fragments from Norra Botkyrka (690-691) are broadly dated to the late Vendel or early Viking Periods ⁽¹¹⁾. The Kaupang and Birka fragments can only be dated broadly to the Viking Period and the fragments from Helgo belong to an occupation layer covering the period from the end of the Roman Iron Age to the early Viking Period.

Outside Scandinavia filigree glass is known from only four locations three of which lie within the British Isles. From this monastery at Whitby, England there is a fragment showing opaque yellow spirals. This excavation has never been fully published and the context of the find is unknown. However, the monastery itself existed between the mid seventh and mid ninth centuries, thus possibly offering a slightly earlier dating for the type of glass ⁽¹²⁾. A further fragment, also unpublished fully, was found at the Brough of Birsay, Orkney, Scotland ⁽¹³⁾. The filigree rod contains opaque white spirals. The fragment was unstratified but other highly coloured fragments of glass found in the vicinity can be roughly ascribed to Merovingian or Carolingian times. Certainly the earliest evidence for settlement at Birsay suggests a date in the seventh or eighth century although the site was at its peak under Norse occupation some time later ⁽¹⁴⁾. The remaining British fragments from Hamwih (Southampton), England show filigree rods with either opaque white or opaque yellow spirals ⁽¹⁵⁾. The first documentary evidence for the site occurs in the 'Life of

St. Willibald' which gives a date of around the year AD 721 ⁽¹⁶⁾. Holmqvist considers that some of these fragments represent a type of beaker similar to one of the reconstructed vessels from Helgö (550) ⁽¹⁷⁾. The final example is unique in that it is the only fragment of filigree glass to be found on the Continent. In terms of source value, however, it may be considered dubious. The vessel which is complete (and also unpublished) stands in the Etruscan division of the Vatican Museum. It is stated to have been discovered in the neighbourhood of Rome. The form which is considered to be typically Merovingian is of a simple bell-shaped beaker and decorated with vertical filigree rods.

Filigree decoration seems to originate in Roman times. Certain vessels dating to the early years of the first millenium A.D. are constructed entirely of polished filigree rods. A good example exists from Severinstrasse, Cologne, although it should be noted that this type of vessel uses the rods to form the whole wall of the vessel itself and not as a specific form of applied decoration ⁽¹⁸⁾. The use of decorative rods from this early period can be seen on a fragment of dark red glass from Porchester, England ⁽¹⁹⁾. Here the execution of the yellow spiral is crude and the rod is far thicker than the later more exquisite rods from Scandinavia. Nevertheless it does seem that there may have been a continuity in this area of craftsmanship. The later examples clearly show by use of rod and coloured spiral a debt to the earlier Roman designs.

In terms of form and chronology, therefore, one can only say that the Scandinavian examples which are complete or partially reconstructed

have forms which are appropriate to the late Vendel and early Viking Periods, and that the dating available tends to support this. The actual location of the finds however is of some interest. In the main they occur either in, or in close proximity to, acknowledged places of mart or trade. Without doubt the fragments from Helgö, Kaupang, and Birka may be said to be the products of lively trade routes and contacts. The Norra Botkyrka fragments are from a site close to the trade route through the Sodertälje passage, and the fragment from Eketorp, a prime site in the western Baltic, is probably the result of a known connection between the Mälaren valley and the continent. The British examples are equally useful in this respect. Whitby revealed evidence of considerable wealth and trading contact, Birsay, Orkney has produced finds indicating a strong manufacturing and trading establishment, while Hamwih is known to have held powerful links with the rest of Europe.

There seems little doubt that the glass was traded, but the fragmentary evidence, certainly at Helgö, Kaupang and Birsay bring about the suggestion that a trade in fragments themselves occurred for the purpose of re-manufacture into other items. The majority of glass fragments from these sites are all highly coloured as indeed are those from Hamwih. Such colours would be most suitable for the manufacture of beads or similar ornamental pieces. Beads, rods and wasters have been found at all four sites, in each case together with evidence of manufacturing and workshop areas.

The complete vessels from Gamla Uppsala (618) and Birka (516) are both from wealthy burials. The grave of the former contained

predominantly prized heirloom artefacts while the latter contained remains of silver objects. Silver artefacts are comparatively rare even at Birka. It may be significant that the glass vessel in this burial was placed in a somewhat exalted position away from the other finds and on a slight rise on the floor of the grave. The third complete vessel, from Hopperstad (334), lay in a grave which although contained less in terms of quantity of finds is nevertheless rich in relative terms compared to other female burials of the period in Telemark. The fragments which appear in burials are so small that they are hardly likely to have been complete at the time of interment even taking into account chemical activity of the earth. It is possible therefore that even a fragment of such a vessel may have been considered an appropriate symbol of wealth to carry into the next world. This factor of quality is a possible reason for their collection or trade at the major manufacturing sites in Scandinavia. Apart from Helgö and Kaupang already mentioned, further finds have recently been discovered since this catalogue was formed at Ribe, Jutland, Denmark (20).

Whatever their purpose or function on these sites, it seems almost certain that they were imported as fragments rather than actual complete vessels. The traditional theory that the Rhineland was the place of manufacture can hardly be supported by the distribution of the fragments of which only the Rome example appears outside Scandinavia and Britain. The exact area of manufacture may never be known although the presence of fragments at Helgö, Kaupang, Ribe and Hamwih points towards a Scandinavian or British workshop.

Vessels exhibiting filigree decoration must be counted among the highest quality glasses from this period in Scandinavia. Their paucity as complete vessels and their comparative frequency as fragments infers a product highly regarded for its quality and for its colour and finesse of decoration.

APPENDIX 2 - REFERENCES AND NOTES

- (1) E. Hougen, "Glassbegre i Norge fra sjette til tiende arhundre", Viking XXXII, 1968, p. 100f. and plate 7a.
H. Arbman, Birka, 1943, p. 228f. and plates 189:3 and 194:4.
- (2) W. Holmqvist and B. Arrhenius, Excavations at Helgö, Vol. II, 1964, pp.250 - 256, and fig. 113.
- (3) G. Arwidsson, "Some glass vessels from the boat grave cemetery at Valsgårde", Acta Archaeologica, Vol. III, 1932, pp.251-266 and plate XII.
- (4) G. Arwidsson, op. cit, pp. 251-266 and plate XIV.
- (5) W. Holmqvist and B. Arrhenius, op. cit. pp. 250-256 and fig. 112.
- (6) W. Holmqvist and B. Arrhenius, op. cit. pp. 250-256 and fig. 116.
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- (8) W. Holmqvist and B. Arrhenius, op. cit, pp. 250-256 and fig. 115.
- (9) H. Arbman, op. cit, p.176f., fig. 130 and plate 192:3.
S. Lindqvist, Uppsala Högar och Ottarshögen, 1936, p.189 and plate 113.
- (10) E. Hougen, op. cit, p.93.
- (11) A. Bennett, "Gravfält och fynd från järnåldern", Fornvännen, 1972, pp. 247-250, and plates 6a and 6b.
- (12) This fragment is unpublished and is stored in the British Museum.
I am grateful to the Assistant Keeper of the Department of Mediaeval Antiquities, Dr.Leslie Webster, for allowing me to examine the fragment.

(12) continued.

Several attempts have been made at publishing the remains of this excavation. The most recent study of the site and the finds has been carried out by Professor Rosemary Cramp entitled "Anglo-Saxon Monasteries of the North" in Scottish Archaeological Forum, No. 5, 1973, pp.104-105.

(13) I am grateful to Mrs. C. Curle for showing me this fragment.

(14) C.A. Raleigh Radford, "The Early Christian and Norse Settlements at Birsay", H.M.S.O. (Edinburgh) 1959.

(15) M.R. Maitland and Muller, "Southampton Excavations", The Hampshire Field Club Proceedings, Vol. XVII, 1947-1953, 1-2.

Also J.R. Hunter forthcoming.

(16) T. Tobler, Hodeoporicon Si Willibaldi , 1874, 14, 308 and 321.

(17) N. Holmqvist and B. Arrhenius, op. cit, p. 252.

(18) F. Fremersdorf, Romisches Buntglas in Koln, 1958, Plate 5.

(19) I am grateful to Dr. D.B. Harden from the British Museum for drawing my attention to this fragment.

(20) The excavations at Ribe were conducted after the catalogue had been completed. The site itself which bears many similarities to both Helgö and Kaupang is currently not fully published.

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