The Flow of Resources in a Changing World

Mapping and analysing import of iron and other everyday goods to Southern Scandinavia c.200-1050 CE using database of scientific based provenances of archaeological artefacts

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ABSTRACT
The influx of prestigious foreign objects into Southern Scandinavia throughout the Iron Age and Viking Age has been studied by many. For example, Roman or Frankish luxury objects would find their way north via trade or through dynastic gift exchanges as part of a conspicuous elite culture. Access to crucial raw materials was in many ways formative for both prehistoric and historic societies. The availability – or lack thereof – of specific resources could determine technological developments, and the need for nonlocal raw materials could shape evolving networks. For prehistoric and early historic times in Southern Scandinavia, the written sources and typological studies have limited value in determining the provenance of various raw materials. A typological deduction based on design can indicate the area of production for certain artefacts, but the raw materials used might originate from elsewhere. Based on scientific methods, this study sets out to map and analyse the geography of the available provenances of materials used in archaeological objects with special focus on iron in the period *c.*200-1050. From where did the raw materials found in Southern Scandinavia originate? Was there a connection between the flow of raw materials and the political situation?

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Introduction

In the Viking Age, *c.*750-1050 CE, one crucial connection for Southern Scandinavia was Britain and Ireland (hereafter the British Isles) – established through raids, settlements, and Danish rulers in England. This case study aims to investigate if the political situation across the North Sea can be documented using the provenances of the raw materials of archaeologically retrieved artefacts found in Southern Scandinavia. The focus here is not on prestigious objects but instead the study searches for the provenances of different raw materials, including what can be defined as *everyday* objects typically without a clear typological provenance. The primary focus is on materials that are not likely to have reached Southern Scandinavia as loot or gifts, for example, gold and silver objects. Instead, more humble materials are examined such as iron, steel, and lead, which are more likely to have been commercially exchanged. Did the political and transport-technological changes in Northwest Europe, 200-1050 CE, also influence the flow of raw materials into Southern Scandinavia, or did trade and commerce of raw materials develop along other lines than the somewhat abstract sphere of dynastic ties between regions, for example?

Theoretical background

The present study finds its theoretical foundation in a relatively recent trend in archaeological research with a reinforced focus on empirical object studies. For this study, the empirical approach implies that the physical archaeological objects – to be more exact, provenances derived from scientific analyses of raw materials – form the foundation for an analysis of contact and exchange in past societies of Southern Scandinavia, 200-1200 CE (Dam et al. in press).

Hopefully, through basic provenance studies of the applied raw materials, it will be possible to examine patterns in the flow of resources in the centuries where practically no written sources exist. For Viking Age and early medieval Scandi-

navia, the present study can reinforce an empirical approach to a field of research that has previously relied heavily on typological studies, numismatics, and written sources (Aannestad 2016; Hansen 2018; Pedersen 2004; Roesdahl 2007, 2018). In this way, the methods presented here are highly relevant for the recent trend of network and social identity studies in archaeology, as exemplified by the research initiative UrbNet (About UrbNet).

This specific approach to archaeological data has been referred to as The Third Science Revolution (Kristiansen 2014) and has, according to some scholars, been opposed to the post-processual approach in archaeology. The alleged revolution in archaeology has met critique (Chilton 2014; González-Ruibal 2014; Huvila 2014; Larsson 2014; Niklasson 2014), and concern has been raised that the increased focus on results from natural sciences will shadow the more humanistic part of archaeological research to the extent that scientific results will be considered more factual and reliant and thus will come to determine the direction for archaeology and its research paradigm (Lund and Sindbæk 2021; Ribeiro 2019; Sørensen 2017). However, a true interdisciplinary collaboration between natural sciences and traditional archaeological methodology can be beneficial (cf. Haase 2019, 27-34; Hansen 2018; Lund and Sindbæk 2021). Whether the starting point for an empirical and object-based study be a traditional archaeological typological approach or provenances derived from physical science, the objects can form the groundwork for analysing past societies within a humanistic or social scientific framework with a focus on human intentions, movements, and identities.

Cooperation between these different research areas is by no means a new occurrence in archaeological studies; on the contrary, it has been an ongoing development since the mid-20th century. The interaction between research disciplines is often a mutually enriching process. In the case of the present study, for instance, new data for metallurgic provenancing have been calculated, spurred by a humanistic set of research issues (Dam et al. in press; Jouttijärvi 2019a). New and improved methods for handling and presenting large amounts of data enable the use of a more considerable volume of data from a geographical and temporal widespread area; data that hitherto existed as scattered and isolated observations (Dam et al. in press; Haase and Hammers 2021; Hansen 2018). One of the apparent benefits of such a consistent application of natural scientific methods in determining provenance is that a much more extensive archaeological data set can be activated involving raw materials, objects, or even small fragments of objects that previously had little or no value in discussions about resource flow, contacts, exchange, or mobility in the past. Potentially, this activates a large amount of archaeological data that, up until this point, has not been relevant beyond the interpretation of the exact structure or site where the object was recovered (Loftsgarden 2019, 76; Løvschal 2016). This creates a much sounder and firmer empirical base for answering specific archaeological research questions acknowledging, of course, that research questions and conclusions derived from the presently available data are only temporary and will be subject to change when new methods, empirical data, or scientific paradigms emerge.

For studies of object biographies (Gosden and Marshall 1999; Haase and Hammers 2021; Kopytoff 1986), the information derived from scientific provenances adds an important new layer of information to the life cycle of objects. Indeed, the provenance of the raw materials of an object can be considered as its birthplace. It gives the option of a much more detailed biography of even seemingly insignificant objects such as iron nails. This is also true for stylistically provenanced objects where, even though the design is imported, the establishment of the source of the raw material can sometimes reveal whether it is local or an object with a local style but made from imported raw materials (Brorsson 2018; Christensen 2019, 105-109; Pedersen 2004, 62).

Several studies that form part of the current research paradigm have emerged in recent years. One of these is "Population genomics of the Viking world", conducted by Margaryan et al. (2020). Through intense genomic analysis of the physical remains of a relatively large number of human individuals, the study aims to investigate the flow of genomes in and out of Scandinavia in the Viking

Age. The aim and outcome of the genomics Viking study are empirical and statistical.

An examination of the import of bronze to Southern Scandinavia, which has several methodical similarities with this study, was recently published by Nørgaard, Pernicka and Vandkilde (2021). Using scientific methods on 543 bronze objects from 3800-1300 BCE, various regions of origin for the tin and copper used in the bronze were found and mapped, areas such as England/Wales, the Slovak Ore Mountains, the Mitterberg area, and the Inn Valley in the Eastern Alps.

Another trend in recent years in Scandinavian archaeology is network studies. Several case studies on Viking Age objects in the North Sea and Baltic regions have been undertaken by Sindbæk (Raja and Sindbæk 2018; Sindbæk 2007, 2008, 2010, 2013). Using distinctive objects such as ceramics and spindle whorls, Sindbæk demonstrates how some specific objects cluster together in certain geographical areas and might relate to their user's cultural affiliation and social identification in opposition to inhabitants of adjacent areas. These areas are sometimes regional and sometimes interregional. The studies illustrate how, by applying network models to archaeological data, it is possible to go beyond simple distribution maps. Regional differences that seem distinct based on a single object group will be blurred or even dissolve when combined with other objects in a network study. An example of this is the areas divided by the Great Belt in the Danish realm which Sindbæk suggests is more unified in the Viking Age than previously interpreted, whereas a division across the Øresund between Zealand and Scania seems more marked. Sindbæk (2008, 2010) also demonstrates how the Viking world materiality consists of goods distributed to larger areas, mainly through a few central settlements or emporiums. If these nodes are removed from the network, the other sites will break apart into isolated entities. We might have already known about the importance of these nodal sites such as Birka, Ribe, or Hedeby from written sources or conspicuous archaeological structures, but in this way, it is possible to emphasize their role in the network through the analysis of quite plain everyday objects. This can also draw attention to less obvious nodes and their importance in the goods distribution of the Viking world.

The network studies and their ability to showcase contacts and movement of goods beyond simplistic distribution maps are an inspiration to the present study. By introducing a large contingent of uncommunicative objects into the studies of networks, communication, and exchange, it should be possible, over time, to radically add to the common understanding of distribution patterns and flows of resources in the past. Even though the accumulated data set for this study does not qualify as "big data", it could definitely be considered "large data" in an archaeological context. The aggregation of the data allows the use of records with very diverse origins in terms of provision history (excavation circumstances, post-excavation examinations, applied scientific analyses, and precision in terms of provenance) to reveal new connections and patterns that were hitherto obscure. One strength in this method is that all objects with provenance can be included – even single finds – because the focus is solely on the movement of material resources from one place to another. When new data is added in the future, the outcome of the analysis will be amplified as abnormalities and vagueness in the raw data will be diluted. Through the use of graphic representations, dispersed material is presented in a more tangible form. These representations can then become building blocks for new network studies. The new results make it possible to start addressing hypotheses of the human motivations and historical reasons for the observed patterns. That, after all, will always be the main focus of human studies.

The project – and the aim of this paper

Within the framework of the research project, Raw materials throughout millenniums, executed by Odense City Museums (see Dam et al. in press), scientific studies of the provenance of archaeological objects were recorded from a large number of previous studies carried out by a large number of individual researchers. The aim of the project was partly method development, partly broad data collection, and partly analysis of provenance data from several angles. The methods and materials used in that research projects are described at length in Dam et al. (in press). The aim of the pres-

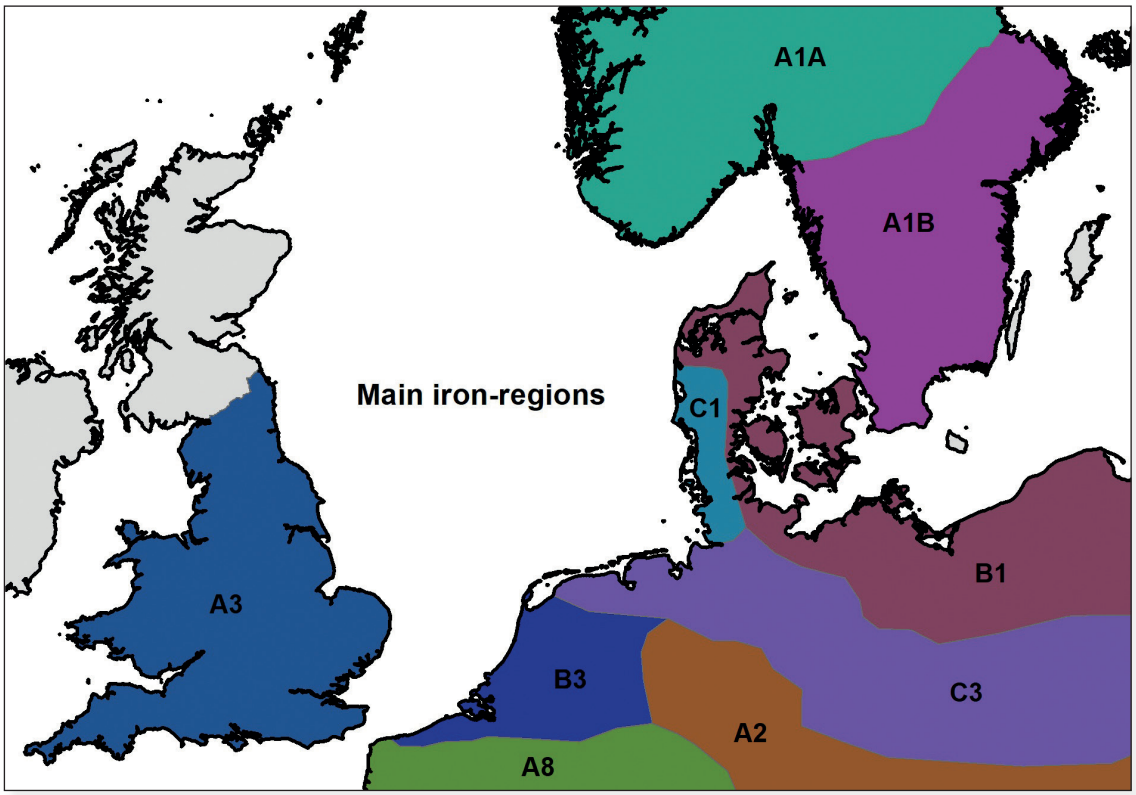

Figure 1: Main iron regions used by Jouttijärvi (2020a) when determining provenance. In some cases, smaller and more specific regions are used. Other researchers of iron provenance use somewhat different regions, for example Buchwald (2005) operates with regions such as Norway, Scania, and several smaller regions (Map: Peder Dam, Odense City Museums).

ent paper, as mentioned, is more narrowly to let the collected data contribute to research questions of whether the political or transport-technological changes in Northwest Europe, 200-1050 CE, also influenced the flow of the analysed types of raw materials into Southern Scandinavia. In this paper, the focus is especially on iron and the proposition of a specific British connection is tested.

As far as possible, all available provenance studies which are considered valid and have a complete set of data have been recorded and mapped in the project using GIS regardless of the type of material, source of information, or applied scientific method. In total, 1410 provenances from Southern Scandinavia 200-1200 CE have been registered and mapped. The provenances have been determined by a wide and very heterogenous range of analyses, depending on the type of material. For example, strontium isotope – and DNA analyses have been used on animals and human remains, dendrochronology has been used on wood, ICP analyses have been used on ceramics and metals have been analysed for combinations of a number of main components and trace elements in each archaeological artefact. These results have, after the analysis, been compared to the general picture for the European regions and beyond. All this data can be accessed by downloading the project's database (see supplementary), in which all researchers and publications are also credited. Furthermore, in these publications, the specific methods related to every record of data are described (Dam et al. in press).

Neither in the project as a whole nor in this paper it is the aim to assess the circumstances of the finds or of the representativeness of the individual objects, as long as the provenance analysis was assessed as valid. On the contrary, the goal is to focus on the overall trends with an expectation that the special circumstances that may occur with the single objects will level off as the amount of data grows. As will be described below, however, some parts of the data are unsuitable to use in studies depending on the questions asked. At the time of writing, some types of material have over-representation from some regions and from some periods, which makes it beneficial to focus primarily on the most numerous and evenly distributed materials in analyses.

The findspots for all objects included in the data set are geographically precise, whereas the provenances are established to large regions only, such as Western Jutland, Norway, or various Central European regions (see Figure 1 regarding iron). Given that many of the 92 established regions of provenance of different materials 200-1200 CE are partly overlapping (such as Norway, Southern Norway, and the Oslo Fjord area), the only possible way of mapping the data is to merge the records into larger data sets – for example, by showing the area-relative concentration of provenances (cf. Figure 7-10 and Dam et al., in press)

In this paper, Southern Scandinavia is defined as present-day Denmark, Schleswig in present-day Northern Germany, and Scania with Halland and Blekinge in the southern part of present-day Sweden. These territories constitute the known extent of the Kingdom of Denmark from the late 10th century perhaps reaching as far back as *c.*600 AD and the first mentions of the Danes (Andersen 2017; Hansen 2015). Any concept of a strong and stable geographic kingdom comparable to historic Denmark in the preceding centuries is at best disputed and associated with significant uncertainty. Having said that, the 10th-century geographical area has been considered an appropriate limit for the long-term studies in this paper combining a good data availability and a relatively well-known geographical and political frame.

The provenanced objects are somewhat heterogeneous regarding the geographical spread of findspots, object age, and types of raw material. For instance, iron objects are richly represented with a total of 169 objects from 200-1050 CE, and while the findspots for these objects are more or less evenly spread across Southern Scandinavia, the finds from 1050 CE onwards almost exclusively derive from a smaller group of urban environments. This results in a geographical and analytical distortion that may affect the outcome of analyses to some degree for the period after 1050. For that reason, objects from 1050-1200 CE are not included in the initial analysis and maps of provenance below. However, these objects will be included in some of the discussions about the results of this case study. Non-ferrous objects in the data set are either rare or more disproportionate for some periods or findspots. The provenances for these objects will be included as a supplement to our investigations of iron flow and specifically in the examination of the British connection.

The analyses below will primarily focus on the provenances of iron objects for two reasons. Partly because they constitute the largest and most evenly distributed data set and partly because we expect iron, which was produced both locally and imported to Southern Scandinavia, to be a good indicator for the flow of raw materials – iron, along with other metals, served as leading products of the economic system (Hilberg 2017, 261-62). Iron can also be considered an everyday commodity as opposed to metals such as gold and silver. For the focus on the British connection in the Viking Age, iron is of interest due to well-documented English iron resources and the appealing notion that iron could have been exported on Scandinavian ships as goods or ballast like soapstone and whetstones from Norway (Baug 2017, 121; Hilberg 2017, 258-262; Loftsgarden 2019, 76).

The iron objects are divided into two groups, the first dating to approximately 200-750 CE and the second to approximately 750-1050 CE. In many ways, the later period (the Viking Age) marks a significant turning point in the history of Southern Scandinavia – the growing use of sails on ships facilitated an increase in seagoing transport, and foreign relations significantly increased politically, commercially, and culturally in those centuries (Bill et al. 1997, 68; Crumlin-Petersen 1999; Hilberg 2017, 258-264). Since the 10th century, in particular, Christianity gained ground in Scandinavia and connected the region culturally to the rest of Europe on a hitherto unprecedented level (Abrams 2012, 25). Scandinavian trade expeditions, raids, conquests, and settlements in the British Isles make up a significant part of Scandinavian archaeological and historical Viking research.

Maps of Iron Provenances 200-750 CE

The data set contains 50 records of provenanced iron from the period 200-750 CE. Geographically the group consists of finds from most of Southern Scandinavia: Bornholm, Zealand, Funen, and most areas in Jutland. As yet, in our data set, there are

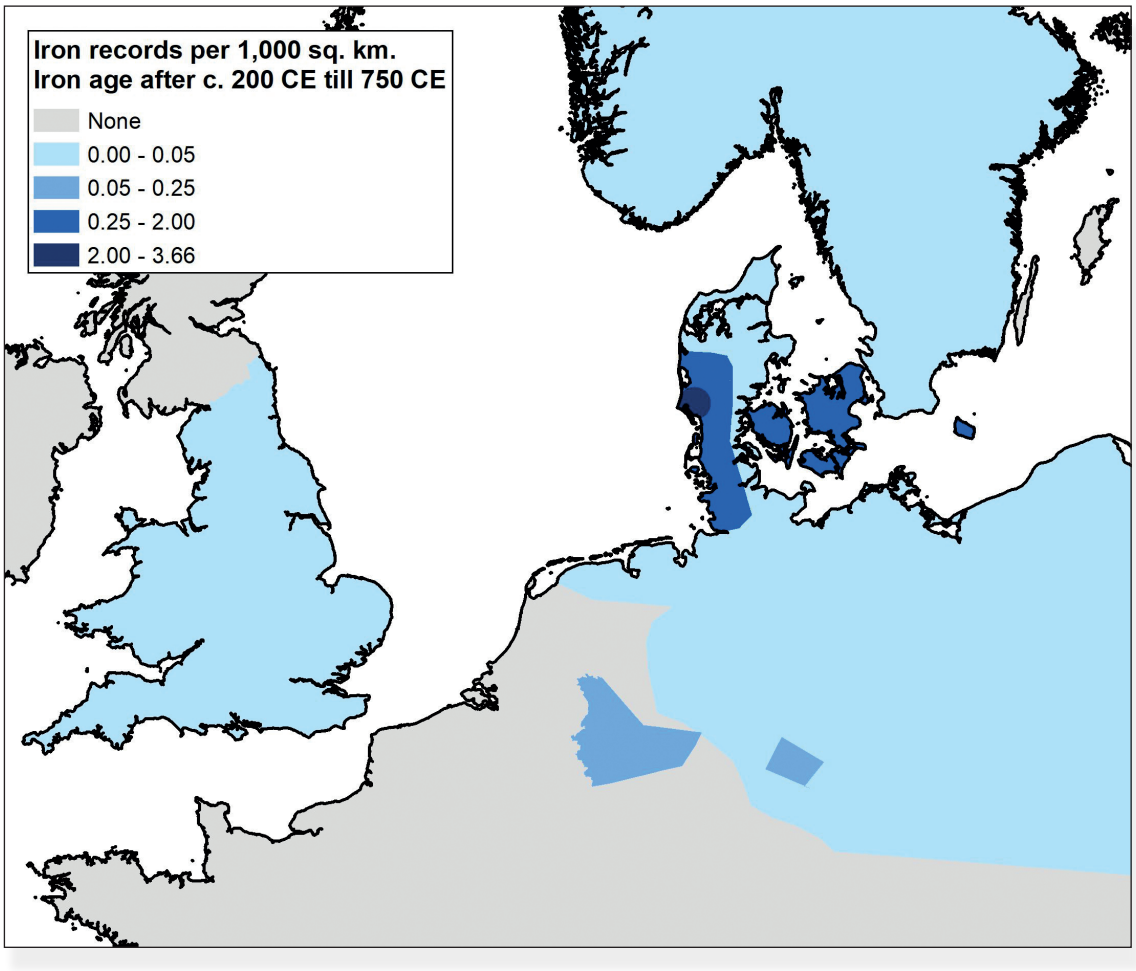

Figure 2: Iron provenances 200-750 CE based on the established provenances of 50 iron objects found in Southern Scandinavia (Map: Peder Dam, Odense City Museums).

no established provenances of iron objects found in Schleswig, Scania, or the northernmost part of the Jutland peninsula. Some of the iron is of local origin, while some is imported from adjacent or more remote regions. Even though the result is not unambiguous, one region, in particular, stands out: Western Jutland (region C1 in Figure 1). This area, situated west of the maximum expanse of the Weichsel glaciation, has significantly more occurrences of bog iron than the rest of Southern Scandinavia, and far more iron furnaces have been excavated in this region than in the rest of Southern Scandinavia (Mikkelsen and Nørbach 2003, 101-106). Of the 50 provenanced objects, 19 have been found to derive from Western Jutland. The group consists of objects found both within Western Jutland and iron found in other regions of Southern Scandinavia. In contrast, no iron objects from this period found in Western Jutland have extra-regional provenance. Future establishments of provenances are likely to change this picture to some extent, but there can be no doubt that Western Jutland was more or less self-sufficient in iron and even exported it quite often – to a much greater extent than other regions in Southern Scandinavia.

A possible distortion of this picture is that the dataset does not include provenanced iron objects found in the Scanian part of the research area; this is in contrast to the subsequent period, 750-1050 CE (see below). As discussed below, Scania at least in historic times had a significant iron production, whereas it is more uncertain how large it was in prehistorical times (Björk 2009; Ödman 2009). In this study, it has not been possible to ascertain provenances from objects found in this area, but further provenance studies may change this.

Local iron production was also present in Eastern Jutland, Zealand, and Funen and its surrounding islands (Lyngstrøm 2018), but no export of iron from these areas has been ascertained for

this period. Furthermore, many of the iron objects found in these areas have extra-regional provenances: Western Jutland (12), the Scandinavian Peninsula (10), Germany and Central Europe (6), and England (1).

Figure 2 maps the concentrations of provenanced materials from this period, illustrated in area-relative values, the darker the shade of blue, the higher the value. A high concentration of provenanced materials can be seen from Western Jutland (0.9-3.7 per 1000 km2). The value for Zealand, Funen, and surrounding islands is also relatively high (0.3-1.9 per 1000 km^2), but this is probably because 24 of the 50 provenanced objects are found in this region. The remaining area-relative values are evenly spread out, apart from the highlighted German regions Sigerland and Schmalkalden, based on two specific provenances of objects, particularly from these small regions.

Overall, the data shows that iron used in Southern Scandinavia 200-750 CE was primarily of local origin or from Western Jutland. There are examples of iron from more remote regions, first and foremost the Scandinavian Peninsula and Germany/Central Europe, but iron was generally a local raw material in this period.

Map of Iron Provenances 750-1050 CE

The data set contains 119 records of provenanced iron dating to 750-1050 CE, the Viking Age. That is more than twice the number from the previous period, and the findspots are also more evenly spread across Southern Scandinavia. Only from Schleswig in present-day Northern Germany, there have been recorded no finds with established iron provenance.

As in the previous period, we see iron of local origin and iron imported from other regions (Figure 3). However, the overall pattern deviates somewhat from that of the previous period (Figure 2). A clear difference is the increase of iron imported from Norway. The raw material from no less than 58 objects has been provenanced to Norway, alternatively Northern Sweden, and a further ten objects found on the Danish island of Bornholm are provenanced to either Southern Norway or Scania. Iron from Western Jutland still makes up a substantial portion (19) especially considering the relatively small size of that region, but there is a clear tendency toward an increase of iron import from the Scandinavian peninsula.

Iron was still produced locally, especially in Western Jutland and perhaps also to a larger extent in Scania, but in reality, many parts of Southern Scandinavia reveal local produced iron such as Funen, Zealand and surrounding islands, Eastern Jutland, and Northern Jutland. However, a possible provenance to Northeast Germany or Northern Poland cannot be entirely ruled out (see Figure 1). The objects with provenances from B1 have been found within the B1 region and are thus not examples of iron export. This contrasts with iron from Western Jutland, which was utilised both locally and in other regions.

The role of Scanian iron in this period still relies on a small data set. Only eight objects found in this region have been provenanced, all of these were nails made with Norwegian iron. While on the Danish island of Bornholm, ten nails were found consisting of material provenanced to Scania, although the iron in these nails might also originate from the southern part of Norway (Buchwald 2005). There is a challenge partly due to the small data set and partly because it can be difficult to distinguish Scanian provenances from those of the rest of present-day Sweden (see Figure 1). Studies in Scania based on archaeologically located iron furnaces and written sources show extensive iron production, *c.*1200-1650 CE, mainly located in the forest regions of northern central Scania (Ödman 2009). Excavated furnaces from prehistoric times are much fewer and mainly located closer to the agrarian settlements further south, east and west, indicating that iron production was then orientated toward domestic consumption (Björk 2009). This is supported by the data set showing no clear indication that large amounts of iron came from Scania to the present parts of Denmark west of the Øresund during the Viking Age, although more data would be desirable.

Most iron imported from other regions came from Norway and Western Jutland. This observation is in accordance with recent studies of Norwegian iron production which show the escalation of production in the latter part of the Viking Age with a surplus of raw material surpassing the local

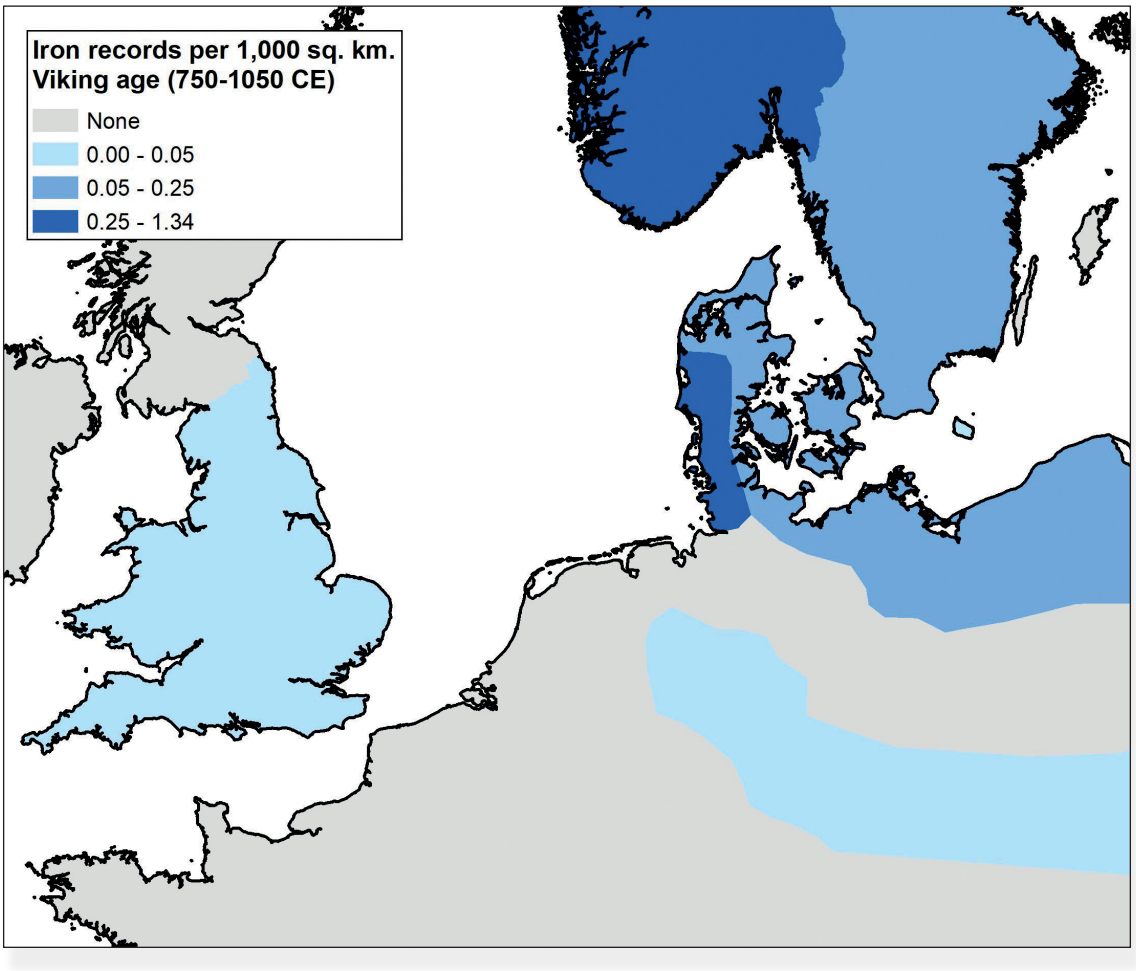

Figure 3: Iron provenances 750-1050 CE based on 119 established provenances for iron objects found in Southern Scandinavia (Map: Peder Dam, Odense City Museums).

demand, thus turning iron into a commodity in Scandinavian trade (Lauridsen and Birch in press; Loftsgarden 2019; Rundberget 2015, 178-184, 2017, 9-10; Tveiten and Loftsgarden 2017, 115-121).

Relative increase from 200-750 CE to 750-1050 CE

Figure 4 shows the relative percentage increase in iron provenances from 200-750 CE to 750-1050 CE. Provenances concentration from the two periods as shown in figures 2 and 3 were compared, and regions where this was decreased are coloured red, whereas regions where this was increased are coloured green. The darker the green, the more significantly the increase.

The most notable difference is seen in iron originating from Norway (an approximate 1000 % increase) and iron originating from Scania (an approximate 600 % increase). The latter admittedly increased from low numbers to average numbers, but the increase for Norway is substantial.

For the other regions in figure 4, it is important not to over-interpret the increase or decrease in numbers of iron provenances. The number of individual records in the data set is still not huge and is geographically skewed. For instance, the increase in British provenanced materials is calculated from just one object in the first period, to three objects in the second. However, what is clear is that significant iron production continued in Western Jutland, and iron was still imported from Germany and Central Europe, although on a relatively smaller scale than before.

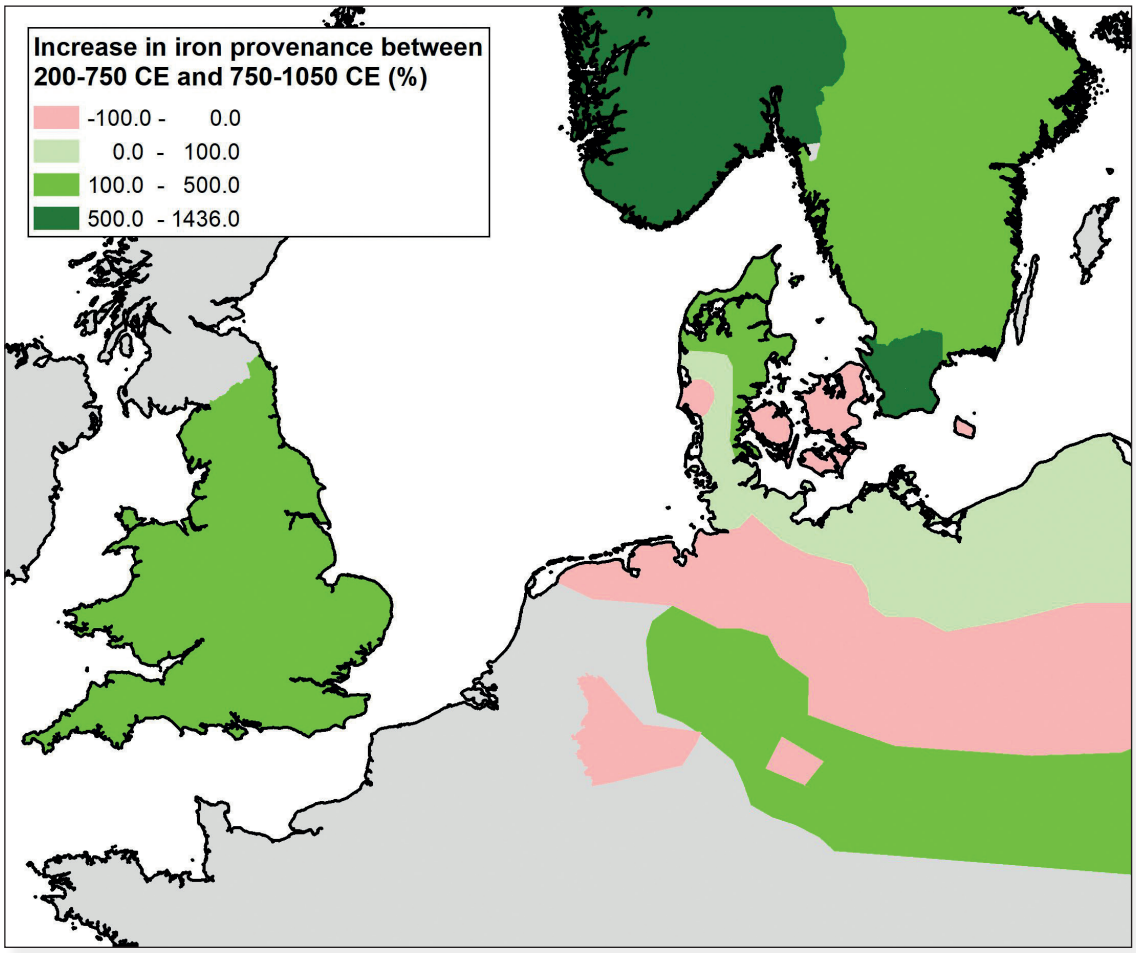

Figure 4: Relative increase of iron provenances from 200-750 CE to 750-1050 CE. (cf. Figure. 1 and 2) (Map: Peder Dam, Odense City Museums).

Differentiated use of iron from various regions, and composite objects

Iron varies in quality and was therefore used for diverse purposes; imported iron was often of higher quality than the locally produced material (Jouttijärvi, Thomsen and Moltsen 2005, 288). Therefore, it is not surprising to find that some types of artefacts where strength was not a top priority, such as nails, could be made of local and low-cost iron, while artefacts where strength and sharpness were of the essence, such as tools and weapons, would often be made of imported iron (Jouttijärvi 2010, 126; Lyngstrøm 1998, 54). The craftsmen of the era possessed knowledge of the different qualities of their raw material and would optimize its use accordingly.

One purpose of this study was to examine if there is a larger contingent of material of British origin when focussing on higher-quality iron and, more specifically, steel in composite Viking Age knives. When singling out specific groups of artefacts from the dataset, the actual number of relevant records will be much lower, making it crucial to take the context of each individual find into account. From an excavation in the town centre of Odense, Denmark, a large number of medieval metal objects have been provenanced. The iron in four out of five knives was provenanced to the Scandinavian peninsula, while the fifth was made of local iron. In contrast to this, two needles, plus seven out of ten nails, were most likely made of locally sourced iron (Jouttijärvi 2019b). These examples from Odense, although post-Viking Age, illustrate the differentiated use of iron, and this tendency is also seen in objects from other sites (cf. Orfanou et al. 2021, 19).

Objects made from two or more different types of material – so-called composite objects – constitute a compelling subgroup. When the provenances for two or more raw materials are established, those objects can reveal information about the site

of manufacture and one or more steps in the object biographies. If all raw materials stem from the same region to that of the findspot, the object was likely assembled locally. On the other hand, if one material is local to the findspot and the other from a different region, the object was likely manufactured locally using partly imported raw materials. Finally, all the materials could originate from different regions to where the object was recovered. In that case, either all raw materials have been imported or the object has been manufactured elsewhere, perhaps where one of the raw materials originated, and the artefact has later been moved to the findspot.

Many knives found in Southern Scandinavia dating from the Viking Age and onward are made with a combination of iron and steel. The result optimises the materials used, combining the hardness and sharpness of the steel and the flexibility of the iron in a very sturdy and efficient blade (Jouttijärvi 2010).

From Funen, twelve Viking Age knives have been provenanced, table 1 (Bech and Lauridsen 2021; Jouttijärvi 2010; Price et al. 2014). Only three of these knives were made from iron that was sourced locally or from a neighbouring region with a similar composition. The steel in these three knives is provenanced to the Scandinavian peninsula and they were probably manufactured on Funen from local iron with the inclusion of imported steel. Five of the knives consist of iron from Western Jutland and steel from the Scandinavian peninsula. The final two knives contain steel from England and Germany/Central Europe, respectively. This subgroup of seven knives could have been manufactured either in Western Jutland with local iron and imported steel or locally on Funen with both materials imported. Only one knife has both iron and steel from the same distant region (Jouttijärvi 2021c), that is Norway or the Northern part of Sweden. As such, the knife seems to have been manufactured in Norway and represents an imported finished object. Finally, one knife (Jouttijärvi 2010) is made of iron from Middle or Southern Sweden and steel from Nor-

Object no.	Date	Provenance of iron	Provenance of steel
OBM4520 x 1731	600-1050 CE	C1 (Western Jutland)	A1A (Norway and Northern Sweden)
OBM4937 x1399	750-1050 CE	C1 (Western Jutland)	A1A (Norway and Northern Sweden)
OBM8414 x 278	750-1050 CE	B1 (possibly local)	A1A (Norway and Northern Sweden)
OBM8414 x 339	750-1050 CE	C1 (Western Jutland)	A1B (Central- and Southern Sweden)
OBM8414 x 378	750-1050 CE	A1B (Central- and Southern Sweden)	A1A (Norway and Northern Sweden)
OBM4520 x 395	750-1050 CE	C1 (Western Jutland)	A3 (England)
OBM8414 x 449	750-1050 CE	C1 (Western Jutland)	A2 (Germany and Central Europa)
OBM8414 x 455	750-1050 CE	B1 (possibly local)	A1B (Central- and Southern Sweden)
OBM8414 x 492	750-1050 CE	B1 (possibly local)	A1B (Central- and Southern Sweden)
OBM16224 x 5	750-1050 CE	A1A (Norway and Northern Sweden)	A1A (Norway and Northern Sweden)
OBM4520 x 1583	800-1000 CE	C1 (Western Jutland)	A1A (Norway and Northern Sweden)
OBM4520 x 1634	800-1000 CE	C1 (Western Jutland)	A1A (Norway and Northern Sweden)

Table 1: Provenances for twelve Viking Age knives, made from iron with a steel core, found on Funen. Knives with uncertain provenances and/or dating have been omitted. Regions of provenance in brackets refer to those established by Jouttijärvi (see Figure. 1).

way or Northern Sweden. This knife could very well have been made in Scania with local iron and imported steel.

Despite the knives representing products that include both standard materials and those of higher and more refined quality, there is almost no link to the British Isles. Of course, British and/or Irish provenance might still be found among special types of higher-quality iron or steel that have not yet been analysed, but so far there is no clear indication of this. In contrast, during the Viking Age, steel was apparently almost exclusively brought into Southern Scandinavia from the other parts of Scandinavia. Of the 64 records of steel, 55 were from the Scandinavian Peninsula, and only one was from England. It could be argued that the single knife with English steel and iron from Western Jutland shows that steel, at least in some cases, was brought from England to Southern Scandinavia as raw material, but the current provenance data set indicates that the influx of English iron and other everyday goods seems of minimal importance.

A British connection?

In the 1980s, it was stated that the archaeological evidence for an Anglo-Danish connection in the Viking Age was so scarce that the finds could hardly evidence the crucial historic events (Olsen 1981, 171). Since then, many metal-detecting finds have shed new light in this field of research.

The connection between the English territories and Southern Scandinavia goes further back than the Viking Age. Around the year 700 CE, Saint Bede, a monk, and the first English historian, described how, from the middle of the 5th century onwards, the Jutes, Angles, and Saxons settled in England from Jutland, Schleswig, and parts of Northern Germany respectively. Although the precise circumstances and the origins of these peoples are debated, the connection between England and Southern Scandinavia is well-documented in this period, at least on an elite level (Hansen 2015, 164-165; Hines 1984, 1992). In the following couple of centuries, neither written nor archaeological sources seem to suggest shared historic ties between Scandinavia and the British Isles. The first documented Viking raid in England was on Lindisfarne Priory in 793 CE. In the subsequent centuries, there were numerous raids and settlements by Scandinavians on the British Isles, and in the late 9th and part of the 10th centuries, large parts of England (Danelaw) were ruled by Scandinavian leaders. In 1013, the Danish king Sweyn Forkbeard (approximately 987-1014 CE) invaded England, and for the following decades, the country was under shifting Danish and English rule.

Given the important ties between England and Southern Scandinavia in the Viking Age and given there is archaeological evidence for iron smelting abundant all over England from the 8th century BCE and onwards (Paynter 2018), it is surprising to see only very few instances of iron from that region in this data set for the Viking Age. Only four objects, three iron and one steel, contained raw material with a British origin. It could be presumed that the close political connection, at least in the later part of the researched period, would have been evident in the provenances of raw materials found in Southern Scandinavia. Indeed, improved maritime technology would have made the transportation of British products or raw materials possible. The raids and extortion of Danegeld enforced by the Danish kings must have also meant a flow of goods to Southern Scandinavia. However, judging from our data set, this influx of British goods did not affect an everyday product such as iron to a significant degree. Southern Scandinavians still relied on local production for simpler iron objects, while high-quality iron was imported from Norway and other Scandinavian regions.

One further approach to assessing the British connection with the data set is to consider all records of objects with British provenances regardless of the type of raw material and extend the period of interest beyond 1050 CE. However, before taking the following into account, it is important to be aware that the non-ferrous objects are not as numerous as the iron objects, and they are more disproportionate in distribution across periods and findspots. Twenty-seven additional materials from *c.*750-1200 are sourced from the British Isles, eighteen of which are wood. Wood makes up a large proportion of the database because there are often many provenanced samples from large archaeological excavations. For in-

stance, 17 samples from the Viking ship Skuldelev 2 have been provenanced – 13 of these from the construction phase are provenanced to the Dublin region, while four samples from ship repairs can be provenanced to Britain (Bonde 1999; Bonde and Stylegar 2011). A solitarily stave from a stave-built tub found in Viborg in central Jutland shows a definitive connection to England as it derives from Northern England, possibly around Yorkshire, and is dated after 1010 CE (Daly 2005, 153).

In total, there are twelve records of metal, including the aforementioned three of iron and one of steel, sourcing from the British Isles in the period *c.*750-1200 CE. Except for some lead from a coffin found in the Abbey Church of Sorø on Zealand, all the metal objects were recovered in or near the town of Odense on Funen (Jouttijärvi 2020c, 2021a, 2021b). Three samples of lead stem from a coffin dated to around 1201 and provenanced to Southwest England (Jouttijärvi 2020b), while a lead ingot from the first half of the 12th century is provenanced to England or Wales (Jouttijärvi 2019b). The silver from a paten and the foot of a chalice, both from a late 11th-century miniature eucharistic set, have a probable provenance in Western England or Northern Wales based on the lead isotope, while the typological analysis indicates that it was manufactured in North-Western Germany (Bjerregaard 2017, 6, 16-17; Ebsen and Jouttijärvi 2018). The rest of the objects are Viking Age: a piece of gold braided jewellery is provenanced to Ireland, while a silver fibula brooch from the Nonnebakken ring fortress is provenanced to England. A raised bismuth level indicates that silver from Arabic dirhems might be mixed in with the raw material (cf. Hilberg 2017, 259-260; Jouttijärvi 2021d).

As mentioned earlier, the steel from a Viking Age knife is also provenanced to England. The knife was found in a Viking Age grave on Funen, and a nearby grave within the same burial ground has recently revealed an intriguing connection to England. Via DNA analysis, the inhumed male has been identified as a second-degree family relation to a male recovered from a mass grave in Oxford. This means that they were, for example, either half-brothers, nephew-uncle, or grandson-grandfather. The individual in Oxford had been violently killed around the year 1000, probably connected with the St. Brice's Day massacre in 1002. His relative in Denmark died of old age but had older lesions on a neck vertebra and the left side of his pelvis which may have been caused by a sword (Bennike 2006; Margaryan et al. 2019, 12-13, 2020, 393). As such, the case of kinship and the knife of partly English origin found nearby tells a very intriguing story of contact between a settlement in Northern Funen and the town of Oxford, with the knife being the only physical proof of actual transportation of raw material or goods from England to Denmark.

Similar to the iron material, there are remarkably few objects made from other raw materials which originate from the British Isles. Furthermore, many of these objects must be considered high-status artefacts. The Skuldelev II ship holds special status here. As a vessel and means of transportation, its purpose is to move, and as such, cannot be considered an import but still demonstrates distinct evidence of contact across the North Sea. Furthermore, even though wood as a raw material could be considered an everyday commodity, the amount of suitable timber needed, and the highly specialized construction of the longship are a manifestation of high status.

In conclusion, the available object provenances do not give reason to believe that there are a number of British raw materials in Southern Scandinavia hidden within objects of local style. The relatively large number of objects with British origin recovered from around Odense does not necessarily indicate a special connection between this area and England but is more likely due to an increased focus in provenance research by Odense City Museums over several years. Overall, in terms of finds and their provenances, object from the British Isles only make up a very small group (Hansen 2018).

Discussion

As described above, there is a significant shift from the use of Western Jutland iron in the period 200-750 CE to a higher use of Norwegian or Northern Swedish iron in the period 750-1050 CE. In contrast to this, the data set does not show a notable increase in materials of British origin for everyday

iron and steel objects despite the increased contact across the North Sea in this period. Future studies of object provenance will refine this overall picture but will probably not change the fundamental conclusion that the strong political ties of the Viking Age only had a limited effect on the exchange of standard goods of iron and steel from Britain to Southern Scandinavia. Other groups of raw materials also have no significant number of British provenances, even though it must be remembered that the number of records of these materials is not as high or as evenly spread as those of iron. In contrast, more prestigious or conspicuous Viking-Age objects have British provenances, which is supported in stylistic studies of English influence in Southern Scandinavia. Those finds include silver coins, riding equipment, and magnificent swords that point to elite groups in society (Pedersen 2004; Roesdahl 2007).

Evidently, English goods of various kinds were transported to Denmark during the Viking Age. In the first half of the 11th century, an increase of English coins found in silver hoards can be seen, especially in Scania. These coins could very likely stem from Danegeld, the coins from which were absorbed into monetary circulation in Scandinavia (von Heijne 2011, 189-90; Moesgaard 2006, 412-413; Roesdahl 2007, 12-13). Some objects, typologically determined as English, have revealed that the concept of export-import is not always a straightforward transfer of physical goods from one place to another. The clay from glazed and wheel-thrown English-styled ceramic found in Lund (Scania) and Lejre (Zealand) has been established as local. Thus, the pottery indicates the import of styles and technology rather than actual trade across the North Sea. This is very probably down to an English, or perhaps Anglo-Scandinavian, craftsman from the Stamford area who had migrated to Scandinavia and perhaps even produced English styled ware for a contingent of English immigrants (Christensen et al. 1994, 75; Larsson 2000, 71-74, 80-83; Pedersen 2004, 62).

Despite a well-documented connection between Southern Scandinavia and England during the Viking Age and not least during the Danish dominion in the first half of the eleventh century, there is no evident effect on the exchange of everyday objects from England across the North Sea. This matter has been discussed previously (Pedersen 2004; Roesdahl 2007, 2018). In their study of the late 10th century ring fortress Aggersborg, Roesdahl, Sindbæk and Petersen (eds. 2014) conclude that archaeological evidence for the exchange of everyday objects from England in Southern Scandinavia is scarce, and even though an increase of English objects can be observed around 1000 CE, the artefacts in question are mainly connected to coinage, warfare or the ecclesiastical strata (Pedersen 2014, 413). English moneyers operated in Scandinavia, and English clerics were appointed to bishop sees within the Danish realm in the 11th century. Thus, the English influence in terms of actual objects, stylistic details, church architecture, and important changes in Danish minting or church organisation is evident but also limited to the highest reaches of society (Abrams 2012, 29; Larsson 2000, 80; Spejlborg 2014).

To understand the scarcity of British influence, at least three propositions must be considered: the relationship between the political alliance and trade/exchange of goods in the Viking Age, the nature of the British connection, and finally, the demand for certain goods in Southern Scandinavia.

Firstly, what influence on trade did the Scandinavian royals and elites, who led the expeditions to the British Isles, have? Sindbæk concludes in his study of the early towns and trade networks in the Viking Age that these "cannot be reduced to a reflection of a political network. The long distance exchange brought its own rules, which did not necessarily support existing political structures. The choice of sites had to match the interest of travellers and the conditions of geography as much as the ambitions of rulers" (Sindbæk 2007, 129). In essence, our analysis supports this conclusion. Changes in the political and dynastic relations during the Viking Age are not clearly reflected in the current data set. The new political ties across the North Sea do not seem to substitute well-established networks within Scandinavia. The iron trade, as with many other commodities, was probably already routinised and specialised within Scandinavian networks, as demonstrated by the increase of imports from the Scandinavian peninsula in this study. These existing trade networks are also evident from Norwegian soapstone vessels and, later on, combs, reindeer antler and quern-stones found

throughout many parts of Southern Scandinavia (Baug 2017). Norwegian iron might have been transported along the same routes and thus made the import of British iron unnecessary.

Secondly, what was the nature of the connection between England and Southern Scandinavia? The current data do not indicate extensive commercial activities. We know, for example, that Cnut the Great travelled from England to Denmark several times and probably many others with him, but was the settling of the Danes in England in general of a more permanent nature, in the sense that the migrated men and women rarely would return to the old country and bring back goods from England?

Recent research on the phenomenon of Viking diaspora (Jesch 2015, 2021) concludes that strong and long-lived ties existed between the Viking diaspora in the settled areas overseas and the Scandinavian motherlands but mainly focuses on the Norwegian connection to the Atlantic Isles and Ireland and especially to Iceland where Norwegians settled in a largely unpopulated land. The evidence for a strong South Scandinavian Viking diaspora in England seems less obvious. Abrams, on the other hand, tend to see Viking diaspora as ties between elite centres that may have affected the hinterlands less, but at the same time does not subscribe to a simplistic view on emigration as a one-way translocation of people (Abrams 2012). Indeed, written sources tell of Danes who migrated, and runestones in Scandinavia tell of Scandinavians who died in England. Also, the aforementioned DNA study reveals a significant Danish gene flow towards England (Margaryan et al. 2020). Although the number of immigrants from Southern Scandinavia is uncertain, there is no doubt, that there was a significant immigration during the period. Find patterns of diagnostically Scandinavia metal objects suggest that these immigrants mainly comprised non-elite rural settlers who upheld their Scandinavian cultural affiliation for at least a couple of generations. The distribution of Scandinavian style ornaments and bullion silver suggests that these objects were not the result of a significant import via the market towns in England but were probably produced locally (Kershaw and Røyrvik 2016, 1676). Most Danes in England should probably be considered immigrants with no active ties to the old countries. The Danish elite probably upheld a stronger connection to Southern Scandinavia and might have travelled back and forth across the North Sea (Spejlborg 2014, 84-85). This seems to be suggested in the mainly high-status quality of many English finds in Southern Scandinavia (Pedersen 2004).

Thirdly, it must be taken into consideration whether there was an actual need and incentive in Southern Scandinavia to import regular raw materials, like iron, from England. The conditions for trade across the North Sea definitely existed with the seagoing, sail-bearing vessels and the contacts established through expeditions and settlements. Depending on the location in Southern Scandinavia, the distance to Norway and England could be much the same, and trade connections within Scandinavia could have been well-established before the connections between Southern Scandinavia and England emerged during the Viking Age. Evidently, iron from the Scandinavian peninsula constitutes the bulk of materials that are neither local nor from Western Jutland. The interest for British raw material in the Viking Age could consequently be orientated towards resources not readily available domestically, locally, or within establish networks, such as lead and jet, or more perishable commodities such as fine cloth. Artefacts with an English provenance were generally restricted to high-class objects.

No final conclusion about the matter can be given here, but it would seem that a political relationship is not necessarily reflected in the influx of trade goods on all levels. At least, there is no indication that the alliance between Britain and Southern Scandinavia affected the trade of everyday goods significantly.

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Declaration of interest

No conflicts of interest are known by the authors in relation to the material addressed in this manuscript.

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