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Medieval and Early Modern European, African and Asian ivories seen through the Data Lens

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Ivories of different natures are one of the oldest materials of artistic expression, and they have been used widely through space and time. The purpose of this article is twofold: on the one hand, to offer a data driven analysis of Medieval and Early Modern ivories in Europe, Africa and Asia (ca. 1000 to 1600); on the other hand, to offer a critical perspective on the proposed query method itself. Nine museums with 2123 objects have been chosen for this analysis, based on the availability of a query endpoint. The proposed method has clear advantages and disadvantages. To the advantages belong the possibility of researching through several museum holdings at the same time (once the dataset is modelled), to query museum object data on view and on deposit all together, to be potentially able to provide insights into a given category from a very broad perspective, but also to search for unusual objects. To the disadvantages belong the fact that data is changeable, and that the selection of the museums is driven by the availability of a query structure. Therefore, the choice of the museums is also problematic, if one wants to address an international comparison. Furthermore, each museum offered data only in specific fields, which adds complexity to an overall query.

Introducing the data lens

Ivory of various forms and origins is one of the oldest materials of artistic expression.[1] It has been used since the beginning of human artistic expression and throughout history, from Antiquity, through the late Middle Ages and into the Early Modern period, and was likewise popular in the 18th century. Some epochs saw a higher production than others, with differences between the continents. Although the material has always been precious and difficult to procure, it ultimately served for an extremely broad range of objects, from sacral to profane. To the sacral category belong a variety of small or portable altars, crosses, figures or statuettes, liturgical objects and candlesticks, croziers and pastoral staffs, altar tusks and memento mori, pax and rosaries, plaques and reliefs. To the profane category belong a variety of arms, saddles, book bindings with ivory covers, caskets, clothing accessories, figures and statuettes, a variety of furniture, games, jewelry, seals, personal items like mirror cases, brush-pots, combs and hair pins, sundials and compasses, tableware, writing tablets and pens, musical instruments like horns and olifants, cornetts, idiophones, lutes, trumpets, virginals, castanets and spinets. Both lists are in no way complete. Hardly any material had such a wide-ranging application in time, space and use cases.

Considering this broad range of applications along with the wide geographical distribution, a macroscopic approach to ivories seems very appealing. Given the intention of this volume with collected essays on Cultural Heritage Data,[2] this approach will be tested with a new method, by addressing ivory object data through query endpoints of museum databases. The purpose of this article is therefore twofold: on the one hand, to offer a data driven analysis of Medieval and Early Modern ivories in Europe, Africa and Asia (ca. 1000 to 1600); on the other hand, to critically reflect on the proposed method itself, as this method is still in the process of development.

Data driven research prefers quantitative approaches, although the contrary is likewise possible and desirable. For a first survey on the uses of ivory seen through the data lens, a quantitative approach has been chosen by analyzing ivory data coming from museums with a query endpoint. This method, unfortunately, has to disregard important ivory collections that do not currently offer this possibility.[3] Only a small number of museums currently provide query possibilities through an endpoint, and

[1] I would like to thank my anonymous peer-reviewers for critical questions and many helpful bibliographical hints.

[2] See the *OLH* journal special collection 'Cultural Heritage Data for Research: Opening Museum Collections, Project Data and Digital Images for Research, Query and Discovery' at https://olh.openlibhums.org/issue/905/info/ (last accessed 20.01.2025).

[3] Important ivory collections which had to be excluded are, for example, the Walker Art Gallery in Liverpool, the Liebighaus in Frankfurt, the Bayerisches National Museum in Munich, the Smithsonian National Museum of African Art in Washington, and many more.

therefore this study is based on nine museums that hold various sizes and collection strengths in ivory matters. While all of the nine museums chosen for this study have substantial ivory holdings, they do not necessarily have strong holdings in the selected time period, or for an international comparison.[4] Museums with substantial holdings in the time period are the British Museum in London (BM = 695 objects),[5] the Metropolitan Museum in New York (MET = 498 objects),[6] the Louvre in Paris (Louvre = 359 objects),[7] the Victoria & Albert Museum in London (V&A = 320 objects),[8] and the Walters Art Museum in Baltimore (WAM = 190 objects).[9] Important museums with smaller holdings in the given time period are the Rijksmuseum in Amsterdam (Rijks = 43 objects),[10] the Harvard Art Museum (HAM = 9 objects),[11] the Carnegie Museum of Art in Pittsburgh (CMA = 5 objects),[12] and Williams College Museum of Art in Williamstown, Massachusetts (WCM = 4 objects).[13] More than 2000 objects (2123 remaining after modelling)[14] have been queried through various endpoints, mostly using APIs, to build a complex dataset with the most possible entries.[15]

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[4] In fact, the museums chosen for this research are heavily Eurocentric, which is due to their location and their acquisition policies. Although this makes the results of this research more fragile, I had to stick with these because of the chosen method of data querying and its evaluation.

[5] The British Museum offers an online accessible database with advanced search and download functions. See https://www.britishmuseum.org/collection/collection-online/guide (last accessed 7.10.2024).

[6] The Metropolitan Museum of Art offers an API query; see https://metmuseum.github.io (last accessed 7.10.2024).

[7] The Louvre offers an API query; see https://collections.louvre.fr/en/page/documentationJSON (last accessed 7.10.2024).

[8] The Victoria & Albert Museum offers an API query; see https://developers.vam.ac.uk (last accessed 7.10.2024).

[9] The Walters Art Museum offers an API query; see https://api.thewalters.org (last accessed 7.10.2024).

[10] The Rijksmuseum offers an API query at https://data.rijksmuseum.nl/object-metadata/api/ (last accessed 7.10.2024).

[11] The Harvard Art Museums offer an API query at https://github.com/harvardartmuseums/api-docs (last accessed 7.10.2024).

[12] The Carnegie Museum has a collection data set on GitHub at https://github.com/cmoa/collection (last accessed 7.10.2024).

[13] The Williams College Museum of Art has a collection data set on GitHub at https://github.com/wcmaart/collection (last accessed 7.10.2024).

[14] All of the data were queried between December 2023 and February 2024. As data is always subject to change, these results may look different in several month or years into the future. In the following text, I have given some object IDs for selected examples, as the total amount of numbers would have made the reading of this essay almost impossible. A full list of object IDs from the respective museums is given at the end of the article.

[15] The general method of querying data through endpoints is explained in the introduction to this volume of collected essays, as well as in several other contributions. The method applied for retrieving the dataset for this article had to depend on the possibilities offered by the museums, for example, an API (Application Programming Interface) or SPARQL (SPARQL Protocol and RDF Query Language) query endpoint. While APIs are currently more widespread than SPARQL endpoints, some museums offer both. Using the simple endpoint approach, an API search can be oriented towards more general queries, while a SPARQL query allows for more focused queries. Both methods can be refined by using an integrated development environment (IDE). The more general queries may have the advantage of retrieving all of an object's available data. Then, once they are all listed and modeled, the data is easier to compare.

There are important factors influencing both the data retrieval and the results, based on different query methods among museums, and different data quality and quantity offered by each museum. Likewise, the query method has an impact on the granularity of the result. The keyhole of the query endpoint provides views into the internal museum database. But each museum decides independently how much one is allowed to see. While some museums offer just some basic information, like the title of an artwork, a date and an artist, others add acquisition and provenance data, and more or less detailed descriptions. But the quantity and quality of data also differs within each museum, since items have been cataloged over time and are naturally inconsistent. Furthermore, some have been cataloged by experts, others by volunteers. Even those museums that wish to offer substantial details, therefore, have more or less incomplete and inconsistent entries. Furthermore, each museum offers its own way of querying, and even when most of them work with an API query, the methods are still slightly different. When, therefore, different query methods and different quantities and qualities of data come together, the combined result is at first glance a disparate number of different categories of information. It requires many hours of data modelling to come to a more consistent dataset, which can then be used with analytical tools.[16] All of the analytical possibilities depend on the consistent and homogeneous entries of every museum in each possible category.[17] Since the query results still offer very limited overlap, consequently the analytical possibilities are likewise limited. Given the limitations of an inconsistent data set, it is difficult to elaborate very precise research questions. But what is available invites one to explore trends of ivory carving regarding objects, materials, and geographical preferences. Analyzing the surviving artefacts in museum holdings does not (yet) give us a precise picture of percentages at the time of their origin, and, certainly, museum holdings reflect the collection's taste of single or combined acquisitions. Nevertheless, there is a vast quantity of more or less precious artefacts gathered in museums, which still make for a critical mass suitable for an analysis. This method needs to take for granted that entries in the museums' databases are correct, even though the quality and quantity of information differs substantially.

This study therefore proposes a survey of ivory objects in museum collections, confirming some well-known characteristics and questioning some less fully discussed features. The value of the dataset lies in its egalitarian approach to a topic, thus permitting

[16] Apart from the already mentioned discrepancies, other challenges are related to the cataloging language, and the different use of ontologies and entries in the database. In the end, the majority of objects have to be crosschecked in order to verify the medium, category and classification, and to guarantee their consistency throughout the combined dataset.

[17] Which includes using the same vocabularies and ontologies, and filling out all of the available fields in the database (e.g. material, date, acquisition date, etc.).

us to look through phenomena from an open perspective. Research usually starts with a precise question and set of interests, which this study deliberately does not do, being guided instead by the options that the very heterogeneous combined dataset provides. But this approach allows us to evaluate critically the quality of the data and the method. The focus of this investigation is ivory that had been carved in the Middle Ages and Early Modern times, between ca. 1000 and 1600. The time span and the geographical expansion are chosen in congruence with the most important developments of ivory carving and trading, which timeslots differ significantly when regarding the origin of ivory, whether it came from the land or the sea, and regarding their use in the place of origin or in export. Sea ivory, and especially walrus, was highly popular in Europe in the early and high Middle Ages, but continued its fashion more in the Middle East. Land ivory coming from the elephant, had also circumscribed time frames in Europe. After Antiquity, the early European Middle Ages had fewer opportunities to procure ivory than the high and later Middle Ages did, leading to the high-time of ivory objects in the Gothic period, whereas after 1600, trading routes and interests changed due to several circumstances.[18] These will be discussed along with the artefacts in the first part of the article.

Acquisitions and bequests

The dataset provides acquisition dates between 1793 and 2022. The vast majority of objects arrived in four big tranches of bequests and acquisition efforts. In 1907, the Metropolitan Museum received a bequest from the Rogers Fund of about 100 Egyptian objects from the 13th to the 15th centuries. This seems to have been the only major donation with a very focused outline in terms of ivory collecting. On all of the other occasions, pieces came from different epochs and places. The second major bequest from Pierpont Morgan for the Metropolitan Museum in 1917 entailed 136 objects, scattered throughout all of the centuries and different countries. The same goes for the 1931 bequest from Henry Walters to the Walters Arts Museum in Baltimore. In 1970, the London museums undertook a big effort to purchase 635 ivory objects (BM 408, V&A 190), seemingly from different donors and vendors, all likewise multifaceted.[19] During these times, museums and donors were certainly collecting their favorite pieces, and

[18] For an introduction to ivory in the Middle Ages, see Koechlin, 1924; Gaborit-Chopin, 1978; Hegemann, 1988: 70–114; Randall, 1993; Marth, 1999: 51–94; Fitschen, 1999: 95–100; Guérin, 2022.

[19] Likewise, the history of collecting seems to have had the same broad view. Looking at the first decade of acquisitions (1793–1802: Louvre 110, BM 29, WAM 19), gives the same broad perspective. Diptychs, caskets and religious statuettes dominate the entries, but the rest is manifold in object, place and time. The last decade of acquisition (2013–2022) brought about 206 pieces into the museum and looks comparatively scattered, with concentrations in the 14th and 16th centuries. More original are 14 pieces from 16th-century Iran, which the British Museum acquired, together with 39 pieces from China. On the collection of ivory in North American museums, see Randall, 1993: 7–9.

therefore acquisitions circled around the more desirable objects, but these major enhancements still offer material for at least a somewhat balanced perspective (albeit often with a Western European focus). On the whole, all of the collections together offer a valuable insight into international ivory carving, which affirms the validity of the dataset – as much as this is possible.[20]

Ivory quality: elephant, walrus, narwhal, and bone

The vast majority of ivory in the dataset is unspecified in its quality, and therefore in the origin of the animal from which it was extracted, and subsequently also in the geographical region where it originates. It is therefore impossible to talk about any percentages between different qualities. Identifying the ivory quality is certainly no easy task and requires expert eyes and training. Relying on the analysis provided by the experts at the individual institutions, the dataset contains 420 objects classified as elephant ivories, and only 185 as walrus ivories. The rarest entries are for whale ivory (4, probably narwhal and sperm whale), rhinoceros (1), and mammoth ivory (4).[21] The dataset suggests that the vast majority of ivory has been imported and thereafter carved in the places of initial importation. Only a very few pieces were already carved in the place of the material's origin (Norway, Ivory Coast, Indonesia, etc.).[22]

Ivory trade routes have been the subject of many studies. They are in fact part of a global system of goods travelling from North to South and South to North, with land and sea routes in between, like the Mediterranean Sea, the Red Sea, or Asia. A number of authors, like Guérin, Gronnenborn, Barrett and others, have worked on the changing preferences for trade routes and the related luxury items that were carried on them, often providing the primary reason for long distant exchange. The circumscribed time frame of this article reflects an important epoch both in walrus and in elephant ivory trading. Ivory could travel very far, which includes elephant ivory going north and walrus ivory going south. African and Asian elephant ivory was highly appreciated during Antiquity, and thereafter in Gothic and Renaissance times. Elephant tusks are certainly the best-known source for ivory, although they are by no means the only one. During the Middle Ages and also thereafter, walrus ivory played an important role, not just as an elephant ivory substitute, but many cultures appreciated the material for its own qualities. Walruses were an important source for ivory, especially in the high

[20] Of 2123 entries, 161 did not provide acquisition dates.

[21] Only 67 items contain bones as the primary material or part of inlay work, which number is certainly far too low. Bone was used broadly as a substitute when ivory was not available.

[22] These relations, like many others, are tricky to compare to actual percentages. The dataset often reveals how precarious the selection of resulting items in the list turns out to be. This will be discussed at the end of the article.

Middle Ages. Although there must have been many walruses in the Middle Ages in the Norwegian Sea, the Barents Sea and the Labrador Sea, there was only one main place where their hunting and trading was by far the most common, namely, the Western and Eastern coast of Greenland. After the Vikings learned how to ship to distant islands, Greenland and even Canada were no longer out of their reach. The Norse people populated Greenland at the end of the 10th century and shortly later established a flourishing trade with several products coming from the walrus, ivory included. The settlement of the Norse population in southern Greenland engaged in trade with furs, walrus tusks, walrus ropes and other items, and got back cloth and food, mostly between the 11th and early 14th centuries, when the Black Death hit Norway (1349–50). In the 14th century the trade from the Western settlement stopped, and in the 15th century so did the trade from the Eastern (Seaver, 2009: 271–292; Star et al, 2018; Arneborg, 2021).[23] Between the 11th and 15th centuries, trade routes from Iceland and Greenland often passed through Norway, which was itself a hub of distribution, trading down the Atlantic coast to England, Flanders, France and Spain, and even to Tunisia and onwards, while on the other side, via Novgorod, with north-eastern Asia (Seaver, 2009; Dectot, 2018).[24] Some oft-cited written sources survive, like the one concerning the Norwegian Bishop Hákon from Bergen, who sent walrus tusks in 1338 to a merchant in Bruges (Seaver, 2009: 274; Dectot, 2018: 167). When Greenland's trade with Norway diminished in the middle of the 14th century, they strengthened commerce with England, while Norway increased imports from Iceland (Gaborit-Chopin, 1978: 114–116; Seaver, 2009: 271–292). Thereafter, trading in whale ivory further south diminished, although it was still in demand in Scandinavia itself, as well as in the Near and Middle East. Walrus tusks were usually imported to Europe via trading centers like Trondheim, Bergen, Oslo, Dublin, London, Sigtuna and Schleswig (Star et al, 2018: 2; Barret et al., 2020:6, 12; Barret, 2021: 180). Walrus tusks arriving in Norway were usually carved in Trondheim, or shipped along with other goods down the coasts.

Other areas beyond Greenland were never as active. Walrus ivory export from the Barents Sea of Arctic Russia was active in the late 9th century and later in the 16th and 17th centuries, but not on the scale of Greenlandic ivory. Iceland, Norway and Russia had some

[23] On the high-time of 12th century walrus export and timber import into Greenland, which was connected with the needs of a growing population and of church building, and ecclesiastical interest in ivory even up to Rome, see, for example, Arneborg (2021).

[24] In the early centuries of walrus trade, often via Trondheim and Novgorod, pieces were carved into gaming pieces, combs and knife handles, whereas in England it was used for ecclesiastical sculpture, such as crucifixes and crosses. In the high time of walrus tusk trade in the 12th century, the use became more diverse, including mirror backs and more complex combs and gaming pieces, occasionally also for crosses and croziers (Barret, 2021: 173–177).

early hunting in the 9th and 10th centuries.[25] With African elephant ivory becoming more available during the 13th century, the walrus trade was slowly abandoned, and from the end of the 13th century, although it began to be less, it was still traded in the 14th century, but was afterwards rather rare, at least in Europe.[26] Not getting sufficient exchange products like iron and timber for their tusks, the settlement in Greenland declined. That walrus ivory being imported into Europe during the 11th to 15th centuries was actually coming in primarily from Greenland has been proven by several DNA analyses (Star et al, 2018; Barret et al., 2020; Arneborg, 2021: 162; Barret, 2021: 178–181). In Europe, the steady decline in trade of walrus ivory from the 13th century onwards went along with the slow increase of elephant ivory and its availability, especially from the 14th century onwards, when walrus played hardly any role. This occurred at a time when art styles switched from Romanesque to Gothic, which went along with a more variegated field of objects and a refined treatment of décor (Roesdahl, 2005; Arneborg, 2021; Barret, 2021).

Then in the 13th and 14th centuries, the Novgorod Republic, depending on Kiev, traded towards the Baltic and Middle East (Keller, 2010: 12–13). Following Keller and others, the 'Scandinavians did more trade with the Muslims than with the Byzantine Christians. They traded in slaves, fur, amber, arrows, swords, armor, falcons, wax, and honey, in addition to walrus tusks, which in the 12th century were also exported to Iran and India' (Keller, 2010: 8).[27] There seems to be evidence that walrus ivory was traded to the Near and Middle East until well into the 16th century, through the trade routes of Novgorod and Bulgar (Seaver, 2009: 271–292; Dectot, 2018: 159–174), and even as far as China and Japan (Laufer, 1913; Dectot, 2018: 166). Also, in the 13th to 15th centuries, the Tartar and Mongol empires seem to have been keen to get hold of the material. They likely traded it further East, but also the Arabs, who were trading with elephant ivory to the Near and Far East, as we have seen, likewise traded and gifted walrus teeth to the Chinese, as a document of the early 16th century shows (Laufer, 1916: 355–358, 367). Although the Barents Sea was one source for walrus ivory, trade did not always

[25] Also, Iceland usually shipped the tusks onward to be carved in Norway, or at a final southern destination. Another hypothesis asserts that Icelandic ivory was frequent before the year 1000. It was then exchanged for Greenlandic ivory until around 1300, and thereafter by White Sea (southern Barents Sea) ivory (Frei et al., 2015: 458). There are records for only one carving workshop in Iceland run by a woman around 1200 (Dectot, 2018: 162–163). Following Laufer, Russia traded in walrus and narwhal ivory from the 9th century, and the Chinese received it through two different trading routes (Laufer, 1913: 331; Arneborg, 2021).

[26] Keller sees furs and stockfish as the major trade items that established the routes that eventually also carried tusks (Keller, 2010).

[27] The Middle and Near East had an ongoing trade of ivories and elephants in ancient times, for example under the Assyrians, and animals and materials travelled from India to Syria, and from Mesopotamia to Palestine and Egypt, and vice versa, but this far-reaching exchange seem to have diminished drastically long before the turning of the age, at least for the Asian elephant (see Collon, 1977).

choose the nearest source, as has been proved for several 12th century walrus ivories found in Kyiv (Ukraine) that originated in Norse Greenland, as a DNA test shows. The authors suppose that other pieces crossing Novgorod and Kyiv probably passed on even to Byzantium and Asia (Barrett et al., 2022).[28] Some early sources confirm that there was long distant trading, even if the origin and route is not specified. Laufer points to an early Arabic source by al-Biruni, written at the beginning of the 11th century, where a tooth or horn from the North Sea was mentioned, which could be interpreted as walrus ivory. This source also tells us about the circumstances of this precious material and its high value, which was known by many populations, such as the Turks, the Egyptians and the Chinese, and mentioned its appropriate use for knife handles. We are also told that compared to other ivories, the color would be rather more yellow than white, and that this ivory quality also had special effects. Laufer points to a similar contemporary early Chinese source, by Hung Hao, who likewise knew that this most expensive ivory quality was rather yellow and used for knives.[29]

Even if the number of walrus ivory figures in the dataset is substantially lower than for those made of elephant ivory, the total of 185 pieces distributed throughout the centuries speaks for their steady demand. Predating medieval elephant ivory carving, walrus ivory had its greatest extent in the 12th century (ca. 145 items), and afterwards became quite rare in Europe, thus coinciding with the busy trade undertaken by the Norse Greenland population. Looking at the 11th century, it seems plausible that most pieces came from England (14 items: most were for personal use, like a book cover, jewelry, combs, reliefs and plaques, and seals, but also two croziers), Germany (seven altars), and France (two religious items), via the early trade routes coming down from Norway, or directly from Greenland. Even remote places like Alaska are confirmed by three items (harpoons and knives). In the 12th century, Norway was a trading center extremely busy producing walrus pieces (70), mostly for games, for which walrus was a fitting medium. Also, the small size of the items made them easy to trade onwards (**Figure 1**). Likewise, Germany (49) produced a high number of gaming pieces (36), but also different kinds of religious items (altars, crosses, plaques, reliefs, reliquaries). England (10) provided individual religious items (a cross, a crozier, a candlestick, and a plaque, but also caskets and boxes). France (six) produced figures with altars and games, and Spain offered one chess piece. The steep decline of walrus ivory in Europe during the 14th and 15th centuries is confirmed by three chess pieces from Germany,

[28] Likewise, Seaver and Dectot (Seaver, 2009: 271–292; Dectot, 2018: 159–174) had claimed that the majority of walrus ivory originated in Greenland and Iceland, and only lesser quantities on the Russian coast.

[29] See Laufer, 1913: 315–319, 353–354. Laufer also explains why neither the Arabic nor the Chinese people could have confused the ivory quality with rhinoceros-ivory (see, for example, Laufer, 1913: 327–330).

Figure 1: Bishop Chess Piece, 1150–1200, Trondheim (Norway), walrus ivory, The Metropolitan Museum of Art (reproduced under Creative Commons license CC0).

one from Scandinavia, and a religious plaque from France. The dataset delivers Asian walrus items only for the 16th century, namely, a dagger and a sword from the Ottoman Empire, thereby confirming the old Arabic source and its description of this popular usage (**Figure 2**). Following Laufer and Seaver, the Persians and Turks seem to have been specially interested and skilled in producing daggers and knives. In fact, walrus ivory was seen as an especially fitting decoration for several kinds of arms, such as knife handles, because of their delicate flame pattern (Laufer, 1916: 362–364; Seaver, 2009: 276–279; Dectot, 2018: 167).

Unfortunately, the dataset does not contain enough pieces of Asian origin that would allow for more telling comparisons. Reindl-Kiel studied the appreciation of elephant and walrus ivory in the Ottoman empire and found enormous numbers of tusks in the inventories that were obviously on hold for some further use in trade and gift exchange, to be carved for knife and sword handles and for daggers, which were so much appreciated in the Ottoman and Islamic world. In 1496, the royal court listed 72 elephant tusks and 12 rhinoceros horns against 740 walrus tusks. This number remained almost equally high in the coming years, and only diminished drastically around 1530, to only

Figure 2: Dagger Handle, mid-16th century, Ottoman Empire, walrus ivory, The Walters Art Museum, Acquired by Henry Walters, 1905 (reproduced under Creative Commons license CC0).

70 walrus tusks (Reindl-Kiel, 2023: 302–304). The walrus pieces seem to come first from Greenland, via Novgorod; then during the Ottoman Empire through the Tsardom of Russia from the White Sea and Russian coast area (Seaver, 2009; Reindl-Kiel, 2023: 302–303). Elephant tusks, although likely more easily available with the conquest of Egypt, were not likewise appreciated by the Ottomans in comparison to walrus, while the latter with its different material and color quality was worthy for use as royal gifts (Reindl-Kiel, 2023: 305–307). As mentioned above, the slow decline of walrus ivory in the 13th century coincided with an increasing demand for elephant ivory. During the given time period (1000–1600), this was imported mostly from sub-Saharan Africa, and only very occasionally from Asia, as those elephants and consequentially also their tusks were smaller than those of African elephants.[30] The long African trade route went hand in hand with other commercial goods, like gold and slaves, which were exchanged in Europe for textiles, arms, horses, glass, paper and other things to take back to Africa. European societies did not trade much with Africa during the early and high Middle Ages. This changed during the 11th century with the crusades to Jerusalem, which took them

[30] African and Asian elephant ivories were widely used in antiquity, when both species were also much more widespread, being found in both continents. While in Africa this meant large parts of North and Central Africa, in Asia, this meant most of the Near to Middle East, from India to Syria, and all places therefore had their own tradition of ivory carving. For the presence and carving of ancient ivory in the Near and Middle East, see primarily: Collon, 1977.

closer to Egypt, and also with the Islamization of sub-Saharan Africa, which intensified the gold trade with the Near East. The high Middle Ages of the 10th and 11th centuries saw an introduction of African elephant ivory into the European market, South Italy and Byzantium, mostly through Egypt. Subsequently, in the middle of the 12th century, European traders, especially the Genoese and Venetians, delivered the European market. Starting in the 13th century, the Strait of Gibraltar became important for ivory traded from Cairo, Tripoli and Morocco, when the Western sea-route became a quicker alternative to feed the European market. In fact, trading significantly intensified in the 14th century, in both directions, towards the Near East and Europe. The Genoese were among the first to ship to the Northern countries, but from the 15th century onwards, the Portuguese also came increasingly into the business, preferring the Western coastline, starting in 1444 on the Senegalese coast, then by 1460 in Sierra Leone. From 1600 onwards, trade interests moved in the direction of India and the Far East, which did not, however, call for an immediate end of trade with West Africa, although the global trade developed more complex interests, when more countries were involved in shipping and the Jesuits established interests in far distant places.[31]

That elephant ivory was more common in some countries than in others depended on their respective trade routes. South Italy was on the route of many ships coming from Egypt or the central North African coast. France and Flanders were either on the way towards England, Germany or Scandinavia, or they were often even end points of northern trading.[32] After the Portuguese first landed in Sierra Leone in 1455/56 and established commercial exchanges on a regular basis, the ivory trade route included not only elephant tusks, but from around 1490 into the 1600s also increasingly included finished objects, following Costa-Gomes mostly 'hunting horns, salt cellars, spoons, liturgical objects and dagger hafts [...] The distinctive characteristics of these objects expressing African craftsmanship and, simultaneously, European functions and iconography...' (Costa-Gomes, 2012: 169). These were often produced on demand and exchanged as gifts between European noble families, and later found their entry into many households for use, and into 'Wunderkammern' for display.[33] Finished ivory products varied significantly in their styles, depending on their origin. Pieces from

[31] For a detailed analysis of the trade exchange, see, for example, Teixeira da Mota, 1975; Mark, 2007; Guérin, 2010; Gronenborn, 2011; Schreg, 2011; Guérin, 2013; Gomes and Casimiro, 2020: 25; Guérin, 2022: 8–11, 17–22.

[32] See, for example, Guerin, after which products manufactured by the French and Flemish textile industries were one of the major exchange goods that then went down south. Nevertheless, its production first of all required an important ingredient for manufacturing, the mineral alum that was mined in Africa and was then shipped along with the elephant ivory northwards from there. In fact, the alum seems to have been one of the driving forces for this trade exchange (Guérin, 2010: 165–168; Guérin, 2013; Guérin, 2015: 37–41; Guérin, 2022:17–22).

[33] That ivory spoons, forks, salt cellars etc., were actually mostly used, and were not merely collected for 'Wunderkammern', has been research by Gomes and Casimiro, 2020.

Egypt provided the basis for the Siculo-Arabic ornamental style with its distinctive decorative patterns, which were then exported to South Italy and Spain. Objects from the Ivory Coast, Benin, Nigeria and Sierra Leone employed a hybrid concept of figural and animal decorations mixed with European taste, which were often produced on demand for the European market by means of Portuguese trading. Several pieces show the coats of arms of various Portuguese families. African decorative motifs and European styles were distributed through prints, mostly in secular works, and occasionally for religious purposes. They were very popular, filling the European markets along the Mediterranean and Atlantic coasts.[34]

The 420 pieces of elephant ivory in the dataset mostly relate to material arriving in Europe as tusks, where they were then carved locally.[35] Looking through the centuries, the 11th and 12th centuries list 15 mostly religious objects from Italy (three altars, four croziers, two religious plaques, but also three olifants, one comb and two chess pieces), 12 mixed pieces from Germany (six religious plaques, one altar, one book cover, three game pieces), four from France (one each of a candlestick, crozier, plaque and a tric-trac game), seven from the Byzantine Empire (three religious plaques, one altar, one box), two from Spain (two panels), and two from Egypt and the Near East (two panels). The categories of pieces can be seen as typical for the countries. Europe had a strong demand for liturgical items, and some luxury or entertainment pieces, while pieces for the Byzantine Empire were mostly concentrated on the liturgy. Islamic countries, southern Spain included, had mostly decorative ornamental panels. The ca. 165 ivory pieces in the dataset for the 13th and 14th centuries come from the most productive time for ivory carving in France, presenting mostly liturgical objects and some items for personal use: 50 altars, 45 religious statuettes, religious croziers, combs, and reliefs, but also 23 boxes, nine writing tablets (**Figure 3**), and two examples of jewelry. Italy figured in with 16 items (a bit of everything: four croziers, one statuette, a mirror case, a comb, tableware, a box, an altar), and Germany likewise with 16 items that were mostly religious: five altars, five religious statuettes, three religious plaques and reliefs, one crozier, and one mirror case.[36]

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[34] On the Ivory Coast ivories, see for example: Bassani and Fagg, 1988: 52–122; Lamp, 2021: 99–121; Hart, 2021: 123–137. See also Vogel, 1989: 85: 'The almost total absence of African models for the Sapi-Portuguese ivories contrasts with the abundance of sources for the Bini-Portuguese objects. We know of no European prototype for the form and decoration of the saltcellars or spoons […] The similarity is especially marked among the spoons: Sapi-Portuguese and Bini-Portoguese spoons resemble each other more than either resembles spoons from anywhere else.'

[35] On workshop set-ups and the commercial side of ivory production, both on-demand and as ready-made objects for walk-in customers, see Sears 1997; Guérin, 2022: 33–41, 60; Baker, 2023.

[36] Other numbers contain: England 14 (mostly religious: five altars, two religious statuettes, a comb, a chess piece), Spain three (religious: altar, reliefs), the Byzantine Empire two (an altar and a book cover), and the Near East four (decorative panels).

Figure 3: Writing tablet and lid, Atelier of the Boxes (French, ca. 1340–ca. 1360), ivory, The Walters Art Museum (reproduced under Creative Commons license CC0).

Also, the 15th and 16th centuries had a vibrant elephant ivory exchange with 138 objects in total. Almost all of the pieces were carved in Africa and imported as a ready object, contrary to most other ivory imports to Europe.[37] The 83 African productions divide into 63 from nowadays Benin, 15 from Nigeria and five from Sierra Leone. Egypt does not figure anymore at this time. Trading preferences in the Ivory Coast changed, and Sierra Leone developed what we nowadays call Luso-African (Mark) or Sapi-Portuguese (Bassani and Fagg) production, which was active mostly between the 1460s and the mid-16th century, and was particularly known for their tableware, salt cellars, spoons and knives, but also for their olifants (hunting horns).[38] The Portuguese traded

[37] See Peter Mark: 'The works, although hybrid in inspiration, are far more African than they are Portuguese. In addition, no documentary evidence exists to indicate that any of the ivories were carved by African artists living in Portugal' (Mark, 2007: 190). See also Vogel: 'The almost total absence of African models for the Sapi-Portuguese ivories contrasts with the abundance of sources for the Bini-Portuguese objects. We know of no European prototype for the form and decoration of the saltcellars or spoons […] The similarity is especially marked among the spoons: Sapi-Portuguese and Bini-Portuguese spoons resemble each other more than either resembles spoons from anywhere else' (Vogel, 1989: 85). See also Hart on the Afro-Portuguese ivories and the ongoing question of their place of fabrication, if by Sapi or Bini, on the Cabo Verde islands, or even in Portugal, where he points to the importance of the islands (Hart, 2021: 123–137).

[38] Mark contested Bassani and Fagg about the date and origin of the early ivory exports. Bassani and Fagg had claimed a Sapi-Portuguese trade largely between1490 and 1600; see Bassani and Fagg, 1988: 61–109. There is an ongoing discussion about the divisions of Sapi-Portuguese and Bini-Portuguese in respect to Luso-African art, and its development along the coast. Vogel sums up: 'It appears that the Sapi people of what is today Sierra Leone were the first to produce carved ivories for Europe, and that Benin became an important source only when production in Sierra Leone declined.

along larger parts of the Western coast, with the resulting Afro-Portuguese artifacts, as described by Gomes and Casimiro: 'The combination of these two words designated a wide range of artifacts made from elephant tusks and produced under Portuguese economic and cultural influence in four areas on the western African shores, namely Sierra Leone (Republic of Sierra Leone), Benin (Nigeria), Yoruba (Nigeria), and Kongo (Angola)'.[39] Mark speaks for an ongoing Luso-African culture, which sometimes was enriched by other regions like present day Benin in the first half of the 16th century, and Nigeria in the second half (Mark, 2007: 190, 199–201).[40] Sierra Leone figures in the dataset with three olifants, a salt cellar and a spoon, which mostly date to the early Luso-African period, whereas one olifant is a little later (**Figures 4, 5**). The pieces from Nigeria date to slightly later and are much more diverse. Tableware plays a major role. Thus, there are salt cellars (three), spoons, vessels, and pottery with ivory lids, but also one olifant and two figurines. The pieces from nowadays Benin also date mostly to the 16th century or later. Tableware plays a lesser role, but a lot of personal items appear, such as combs and jewelry. Dominant are 14 trumpets and olifants, and 13 altar tusks; both were items often produced on demand. This may also be the case for the three sword handles, which were otherwise produced more often in the Near East and Europe. In 15th- and 16th-century France (20), the immense importation of elephant ivory was definitely being scaled down and few religious items were produced. The six altars, one religious figure and one pax are hardly comparable to the former abundance. Some personal items continued, like jewelry, combs and a little tableware. Italy had a more widely-spanning production with different religious and personal items. There figure three Benedictus knives with ivory handles, and musical notations on the steel that were used in convents. Other religious items are rare (altar, cross, statuette), as well as personal items (box, comb, mirror case).

On the whole, in theory but also in practice, there was no substantially different use between elephant and walrus ivory, which rather depended on their availability. On aesthetic grounds, walrus was often cited as being slightly darker or more yellow, whereas elephant ivory appeared rather white and soft. The Gothic period picked up

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The Congo River area was never their equal as an exporter of carved ivories' (Vogel, 1989: 84). See also Vogel, 1989: 84–89, 104; Mark, 2007: 189–211; Costa-Gomes, 2012: 167–188.

[39] Gomes and Casimiro, 2020: 24.

[40] Bassani and Fagg (1988) had argued that the mid-16th century exports from Sierra Leone became rare, and therefore that trade moved eastwards to Benin and Nigeria, becoming known as Bini-Portuguese, which were predated by Mark: '… the artists clearly were responding to a hybrid Luso-African culture presence that was first established on the West African coast from Senegal to present-day Sierra Leone in the late fifteenth century' (Mark, 2007: 190, 199–201). See Lamp on the Mani invasion in mid-16th century Sierra Leone and its consequences in the second half of the 16th century that had an impact on art and culture (Lamp, 2021: 99–121).

Figure 4: Lidded Saltcellar, Sapi-Portuguese artist, 15th – 16th century, elephant ivory, The Metropolitan Museum of Art (reproduced under Creative Commons license CC0).

Figure 5: Spoon, 15th – 16th century, Edo peoples (Bini-Portuguese artist), Nigeria, ivory, The Metropolitan Museum (reproduced under Creative Commons license CC0).

on the religious and profane object types of the Romanesque period, often executed in walrus, but preferred the more elegant and luxurious appearance of the elephant material. There were a variety of animals living on the land or in the sea which also served as sources for ivory in the Middle Ages, often substituting for what was not available at a certain time and place. Although whale ivory was certainly more common in the north, Scandinavia and Scotland, it could likewise appear in other European countries. In fact, even in Northwestern Spain, hunting whales was a common tradition (Gaborit-Chopin, 1978: 119). Whale tooth as a source for ivory carving was extremely rare (narwhal and sperm whale), and most of them seem to have been from

the narwhal, a unicorn whale,[41] whose yellowish ivory was believed to be miraculous in China and Japan because it was said to eliminate the effects of poison for those who held it in their hands (Laufer, 1913: 315–316, 350). This story is similar to those about the fabulous unicorn, of which medieval sources narrate similar miracles.[42] Narwhal horns were traded to places like England as well as to the Near and Far East, including China. Like walrus ivory, this material was preferred for knife-hilts (Laufer, 1913: 343; Dectot, 2018: 168–169).[43]

In the dataset, the small number of whale ivories includes two 12th and 13th century chess pieces from Scandinavia (MET, **Figure 6**), a 14th century Christ figure from France (Louvre), and a 16th to 17th century fantasy figure handle from Indonesia (BM).

Figure 6: Rook or Pawn Chess Piece, 12th century, Scandinavian, whale ivory, The Metropolitan Museum of Art (reproduced under Creative Commons license CC0).

[41] As researchers have said, it seems unlikely that medieval hunters were able to pursue this species which lived far off on the ice. They therefore proposed that hunters might instead have found dead animals on the shore, from which they took their horns (Dectot, 2018: 169–170).

[42] The origins of the fabulous, poison-reacting horn are manifold. Following Ettinghausen, this was ascribed to the rhinoceros horn in the late thirteenth century in Islamic literature, and reinforced in the 15th century (Ettinghausen, 1950: 110–132). Others believe that it was connected to walrus teeth already in the 11th century (Lavers and Knapp, 2008: 306). Einhorn notes several medieval sources with the story, where other animals drink out of a sea only after the unicorn had detoxified the water poisoned by the snake, or that the animal detoxified the river Jordan before a baptism (Einhorn, 1998: 72, 339–340).

[43] There is an ongoing discussion on the much appreciated material of khutu, an ivory quality often used for daggers and knife handles all over medieval Asia, which some researchers either identify with walrus, or narwhal, or both (see, for example, Laufer, 1913, 1916; Ettinghausen, 1950: 120–142; Lavers and Knapp, 2008; Gillman, 2017). Wiedemann even suggests an identification with mammoth ivory (Wiedemann, 1911).

Unfortunately, the whale tooth quality is not identified. France had an ongoing trade exchange with Scandinavia during the Middle Ages, from which it must have received a raw piece that was carved in France, whereas the piece from Indonesia was likewise carved on Java into a typical Asian fantasy figure, which could either be a more local sperm whale or an imported narwhal that came a long way by ship on its way to China or Japan.[44]

Finally, four items are categorized as being mammoth ivory (MET) coming from China, where they were carved between the 12th and 14th centuries into two Buddha and two Bodhisattva figures (**Figure 7**). In this particular case, the question is whether people realized that they had found something extraordinary and therefore chose the deities as appropriate transformations.[45]

Figure 7: Buddha Shakyamuni with attendant bodhisattvas, 12th–14th centuries, China, mammoth ivory, paint, The Metropolitan Museum of Art (reproduced under Creative Commons license CC0).

When neither elephant nor walrus ivory was available, bone was seen as an adequate alternative. This was true for many countries, like Italy and Germany, and already Theophilus Presbyter seems to have used both terms interchangeably.[46] In any case, what Theophilus recognized as ivory was probably walrus ivory, since he appreciated

[44] Laufer mentions trade possibilities for walrus and narwhal ivory to China and Japan via Russia, via the Arabic countries, and later on in the 16th century, on the Portuguese or Dutch shipping trading routes (Laufer, 1913: 349–350. See also Arneborg, 2021).

[45] One piece of rhinoceros ivory, for example, ended up in China, where in the late 16th century it was used to produce an ivory stand for a Guanyin statue (HAM). On mammoth and rhinoceros ivory, see Laufer, 1913: 345, 354–356; and Guérin, 2022: 8.

[46] On Theophilus' description of ivory and bone, see: Bänsch and Lindscheid-Burdich, 1985: 374; Barnet 1997: 6–7; Marth, 1999: 52; Guérin, 2022: 27.

it mainly for knife handles, the typical application of walrus material around 1100. Nevertheless, large quantities of objects were made out of bones from different species of animals, such as camels, cows and horses. In quite a few cases, bones and ivories were combined for larger objects, like caskets and boxes, where larger amounts of material were required. When using bone, quality mattered less in cases of multi-material works, especially for inlays, of which Italy, Spain and Egypt produced quite a lot.[47]

Gilding and painting on ivory

Gilding and painting on ivory seems at first glance an anachronistic approach, given the rarity of this expensive material, which was praised precisely for its soft white color and velvety surface.[48] Regardless, the Middle Ages had a different approach to the use of color. Painting on marble sculpture was also quite widespread from the middle of the 13th to the middle of the 15th centuries, especially during the 12th- and 13th-century Near East, and the Gothic period in Europe. Around 118 objects of elephant ivory had been painted or gilded throughout the centuries, with a steep decline from the 15th century onwards. Almost all of these objects have lost their color with only traces of polychromy remaining, which makes a comparative analysis close to impossible. This is probably also the reason why gilding and painting on ivory has been little studied in the scholarly literature.[49]

As this survey shows, painting and gilding occurred already on pieces predating the Gothic period, which is usually mentioned in these matters (for example, Fitschen, 1999: 96). Naturally, polychrome sculpture as such had an influence on ivory decoration, but the European Romanesque sculpture was not the only influence. Polychrome ivory was already in use in eastern countries. An important influence comes from the Near East, over Islamic and Byzantine objects and their southern European influences on Romanesque pieces in Spain and Italy, then moving on to central Europe. The eastern color palette was more reduced, limited mostly to two or three nuances, whereas the Gothic preferred decorations with four or five colors. The three earliest occurrences in the dataset (all from the Louvre) are from the 11th century: two Byzantine pieces, a religious plaque with the Virgin (OA 11128), and a religious comb with lions and birds (AC 866), and from Southern Italy a Triptych from Amalfi (OA 7350). These are followed

[47] On inlay work, see for example: Siculo-Arabic ivories and Islamic painting 1100–1300, 2011.

[48] Querying ivory in museum collections brought to light some related topics, such as ivory glaze on ceramics and paper. Although these have been excluded in the final dataset, I would like to offer a brief overview here: Ivory glaze appeared 18 times, almost exclusively related to tableware in China in the 12th century (dishes, bowls, plates). The set included a ewer from 14th century Vietnam, and a 16th century tea caddy from Japan. Ivory glaze on paper occurred nine times, mostly on Japanese 16th century hanging scrolls, and once on a French 14th century mirror case.

[49] The vast majority of entries with information in the dataset come from the Louvre, with few or no entries from other museums. On gothic painted ivory see, for example, Gaborit-Chopin 1997; Dale, 2021; Webster, 2021.

by two tric-trac games from Normandy and Cologne (OA 166 and OA 10003),[50] and two croziers from Sicily (OA 112 and OA 11776), all from around 1150 (all Louvre).[51] Producing gaming pieces, as we will see, is a tradition that came from the Near East. From Islamic regions another tradition was introduced as well, that of small precious boxes made of ivory, which could receive gilding and a painted coloring, either on a plane or a carved surface. As Randall has shown, 'Islamic works made by Islamic craftsmen for the European market, in addition to the oliphants, were the so-called Siculo-Arabic boxes of Sicily, which were produced from the twelfth to the fourteenth centuries [...] The surfaces are decorated with painted subjects, usually in a pale-brown pigment with darker brown for emphasis and details picking out with gilding' (Randall, 1985: 151). Two of these early Siculo-Arabic boxes dating to the 12th and 13th centuries with pale-brown ornaments on elephant ivory are present in the dataset (both Pyx boxes, WAM 23356, **Figure 8**). The same influence is probably true for the two painted Italian croziers (Louvre, OA 11227 and OA 11776), but the remaining color pigments do not allow for further judgements.[52] It does seem plausible, therefore, that the techniques of

Figure 8: Box (Pyx), 12th–13th century, Sicilian Artist, elephant ivory with paint, The Walters Art Museum (reproduced under Creative Commons license CC0).

[50] A recent analysis of the late 12th to early 13th century Lewis Chessmen pieces from Trondheim, found in Scotland, has shown that they were originally covered at least with a red color (Tate et al. 2011: 257).

[51] The dataset contains in total 64 entries for generic, unspecified ivories that were painted or gilded. The non-classified ivory qualities confirm similar geographic areas. Looking at the 11th and 12th centuries, the five entries are for two religious reliefs and plaques from Spain, one casket from Spain, one comb from Sicily and one Olifant from southern Italy.

[52] Gaborit-Chopin had referred likewise to these Siculo-Arabic boxes for the decoration of a southern French crozier from Arles (second half of 12th cent.) with a painted entombment scene (Gaborit-Chopin, 1978: 113). On painted croziers in Italy, see: Gaborit-Chopin, 1978: 162–164.

painting and gilding on ivory were often connected to Islamic and Byzantine practices, where ivory had a longer and more stable history throughout the Middle Ages.[53]

The high time of polychrome ivory was during the European Gothic period. Most of the more than 90 painted or gilded objects dating to the 13th and 14th centuries have a religious background (43 figures, 25 altars, five croziers, four plaques). The non-religious objects are six caskets and five writing tablets. Not surprisingly, all of these categories include examples from France. Pieces from Italy (Venice, Naples or Sicily) include six religious items, croziers and plaques (WAM 24336, Louvre OA 7268, OA 2767, OA 7267, OA 6087, RFML.OA.2018.57.1), from England four religious objects, a diptych, and a small sculpture (while the polyptych was manufactured in Exeter). From Germany there is one diptych from the Meuse Valley (Louvre MRR 424) and three figures and reliefs (**Figure 9**), from Belgium a diptych from Liège (Louvre OA 9330), and another diptych from Spain (Louvre OA 10009).[54] The 15th and 16th centuries figure with

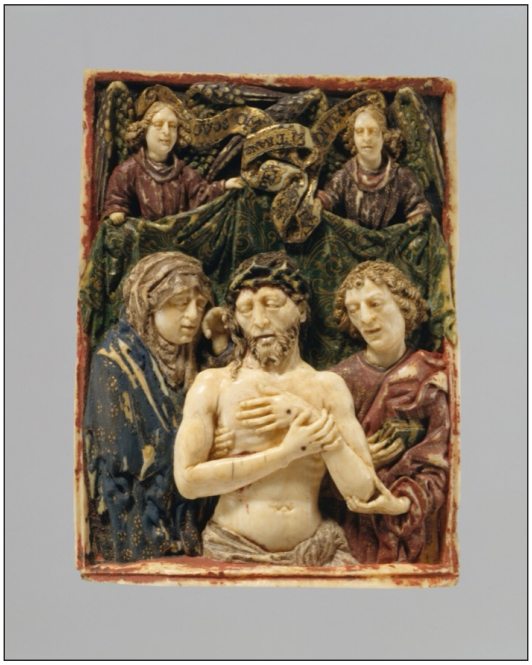

Figure 9: Man of Sorrows, ca. 1500, South German, elephant ivory with paint and gilding, The Metropolitan Museum of Art (reproduced under Creative Commons license CC0).

[53] This hypothesis does not intend to neglect the fact that polychromy on European sculpture occurred likewise as early as the 12th century, as has been demonstrated for several religious sculptures in Germany and France (see Dale, 2021: 158–162). Webster supposes a similar treatment for sculpture in ivory and wood or stone. Polychrome sculpture might even date back to the 9th century, from a time in England when some traces were found on religious sculpture (Webster, 2021: 207–209). Nevertheless, in Europe polychromy was rather rare during the Romanesque period.

[54] The 39 undefined ivory objects from the 13th and 14th centuries contain 18 mostly French altars, 16 mostly French religious figures, three croziers from Italy and Germany, three plaques and one Sicilian casket.

only eight entries, which seems plausible for the 16th, but less so for the 15th century, where painted sculpture was widely used, at least in the first half of the 15th century. From France, there are one diptych (Louvre OA 52) and one comb; from the Netherlands a religious relief (MET 464266) and a comb (Louvre OA 146); from England two figures, religious and profane (Louvre OA 274), and from China a crucifix (Louvre OA 12538), probably shipped from Europe.[55]

Since colored ivories as a phenomenon are more common in the late Roman and Gothic periods, the dataset contains far fewer entries for painted walrus ivory, eight in total, of which seven date to the 12th century, the period when walrus ivory carving was at its height. From England come two caskets and one religious plaque (Christ before Caiaphas. MET 471919, Louvre OA 11342 and OA 11343), from Germany one religious relief (Nativity, Rijks BK-15622) and two tric-trac games (Louvre MRR 427and MRR 428), from France a religious plaque (Descent from the Cross, MET 464156). To these can be added a 14th-century painted whale ivory with a statuette of Christ from France (Louvre OA 7269). The only whale ivory (narwhal?) appearing in this category is a 14th-century Christ statuette from France (Louvre). These entries would point to painting on walrus ivories not originating in Scandinavia itself, but in central Europe, where elephant ivory painting and painted sculpture in general were already in practice.[56]

Personal items

Research has produced substantial studies on ivories related to religious subjects, especially on altars and statuettes. Personal items, however, are better situated for an international comparison of object types and ivory qualities. Personal items are an interesting category because some have a distinctive local touch, like bracelets and arm cuffs coming mostly from Benin, while others, such as gaming pieces, combs and hairpins, and to a certain extent also mirror cases, look almost the same in many countries. This speaks for a wide distribution of the objects, which were easy to transport and trade, and were greatly desired as luxury objects by patrons worldwide.[57]

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[55] This item is right at the edge of my time frame. Later unspecified ivory works from the 15th and 16th centuries include small religious items, with only two altars, one figure and one reliquary; otherwise, there were three caskets, two French medallions and pendants, one comb and three German compasses and sundials.

[56] The dataset contains only about 10 occurrences of painting and gilding on bones, which is certainly misleading, given that, for example, the plenitude of caskets from the Embriachi family were often painted. The objects are, for example, a painted and gilded Spanish casket from around 1200 (MET), a cabinet from the Embriachi family with gilding from around 1400 (MET), and a religious plaque from 1400 with painting (Louvre).

[57] Unfortunately, the dataset is little representative for arms, such as daggers, knives and gun handles. The few objects have a concentration in 16th-century European arms, whereas a comparison between East and West would have been useful.

Personal items: Luxury, vanity and jewelry

The use of ivory for personal items and jewelry (203) was common throughout all the cultures represented in the dataset.[58] This category comprises objects like hairpins, combs and brush pots, pen cases and paper cutters, armlets and finger-rings, medallions and pendants, mirror cases and more.[59] The number of objects increase over time, with peaks in the 14th and 16th centuries, the most prolific eras for ivory carving. Most fashionable among the surviving artefacts in museum holdings are mirror cases (73), followed by hair combs (49), medallions and pendants (33), with some bracelet and armlets. The three earliest objects are made of walrus ivory and were produced in 11th-century England: a comb, a medallion, and a pen-case (BM 1957,1002.1; 1987,0305.1; 1870,0811.1). In the following centuries, personal items were mainly unspecified ivory (132) or elephant ivory (55). The unspecified ivory was probably walrus, since at the height of walrus ivory trading during the 12th century, many combs, mirror backs and other pieces were manufactured (see note 24). The probably smaller group of elephant ivories likewise contains mostly mirror cases and combs that were mainly carved in France (28) (**Figure 10**), and only exceptionally in nowadays Benin.[60] France seems to have produced the vast majority of these vanity and luxury items (76), followed by Italy (26). Again, the 14th century was the most productive, with ca. 75 items, followed by the 16th with around 50 pieces.

Ivory combs were widely used over space and time. Romanesque combs tend to be rather simple, rarely decorated, with crests more on one than on two sides. In the Gothic period, while the quality of carving may differ between the regions of origin, the decoration pattern itself does not differ very much, which means that there was some European consistency on how to decorate a comb.[61] The dataset contains 14 entries each for Italy and France, with single pieces from Germany (BM 1916,0403.1), Netherlands (V&A O166122, Lou OA 146), England, Benin, China (V&A O126756), and elsewhere. In Europe, these combs usually had crests on two parts, whereas the comb from Benin

[58] A brief overview: 80 objects from France, 28 from Italy, 10 from England, eight from Germany, four from the Netherlands, one from the Ottoman Empire (mirror), 13 from Benin (arm cuffs, armlets, bracelets, combs), two from Egypt (beads and ivory), nine from China (brush-pots, medallions, combs), one from Tibet (medallion).

[59] Of the 203 objects, 66 are from the British Museum, 44 from the Victoria & Albert Museum, 33 from the Louvre, 32 from the Metropolitan Museum, and 25 from the Walters Arts Museum.

[60] One would expect early pieces from Africa as well, like bracelets and armlets, but the dataset hardly contains any for this time.

[61] Ashby has done an analysis of high medieval combs and noticed a north-western Europe congruency for the combs with two crests, where he noticed a high time for the 10th to 12th century in urban settlements (Type 4, 14). He only considers the decorative pattern for late antique double-faced combs and the highly rare type 14c with figural, vegetal or geometric patterns (Type 10, 14c). In any case, combs with two crests appear rather as an exception in his study of high medieval artefacts from the British Isles (Ashby 2011, Type 4, 10, 11, 12, 13, 14).

Figure 10: Mirror Case with the Fountain of Youth, ca. 1330–1340, French, ivory, The Walters Art Museum (reproduced under Creative Commons license CC0).

had only one crest and a typical African figure on the other end (BM Af1958,10.2). In Europe, the part between the two crests was often filled with ornament or figures. These could be either animals or a scene taken from courtly life or literature, like lovers in a garden, or the 'Judgment of Paris' (**Figure 11**).[62] Likewise, decorating mirror cases was a concordant idea, with more or less the same decoration schemes that we find on the combs, including love scenes, some classical mythology like 'Pyramus and Thisbe', and some religious motifs, mostly Marian decoration. Following Randall, '[m]ore mirror cases have survived than any other form of secular ivory' (Randall, 1997: 71). Although mirror cases date back to the 12th century and were probably already then in use over Europe, the origin of mirror cases was not as widespread as that of combs. Of the 73 mirror cases in the dataset, the vast majority of 50 result from 14th-century France, and seven are attributed to 14th- and 15th-century Italy. The case of writing tablets is similar to that of the mirror cases (see **Figure 3**). The external decorations, usually a diptych type with carved outer panels and a wax slide inside, had decorations coming from the Bible, courtly love scenes and courtly classical mythology. Writing tablets date back to Graeco-Roman times and must have been common during the Middle Ages, although it is difficult to find an example before the 14th century. Being carved out of ivory, or more frequently wood, they often had a decorated cover and a back filled with wax to

[62] On Romance topics as ivory decoration, mostly in France, Germany and Italy, see Randall, 1997. Following Randall, the 'majority of surviving ivory combs are also carved with scenes of lovers' (Randall, 1997: 7).

Figure 11: Comb with the Judgement of Paris, 1500–1535, French, ivory, Louvre (© 2005 Musée du Louvre/Pierre Philibert. Reproduced under the Louvre image copyright: Re-use free of charge for digital scientific and educational publications).

allow writing by scratching. Sometimes they could even be bound as books with several 'pages'.[63] Again, most of them, 45 in total, came from 14th-century France (36), while Germany produced just a few between the 14th and 16th centuries (V&A O172039, O312381, O152503; Lou OA 7764, MRR 42). Although we have seen that vanity and luxury objects occurred in 12th century walrus carving, and were subsequently taken over by the French 14th century, they ultimately became a sign of the great production of elephant ivory carving in Gothic France.[64] Mirror cases and writing tablets became a quintessence of the courtly lifestyle, more than combs, which were far more widespread. Combs nevertheless followed a similar decorative scheme, which speaks for a pan-European taste in luxury items.

Personal items: Gaming

Gaming pieces made out of ivory go back to Antiquity (and even earlier). In particular, chess became fashionable towards the end of the first millennium, and the oldest known pieces are said to have originated in the 9th century in India and Persia (Randall, 1985: 150). The dataset contains a significant number of 202 objects related to gaming. These include mostly chess boards and figurines, but also some other draughts-pieces,

[63] On writing tablets, see: Schewe and Davis, 2019: 237–243.

[64] The ivory quality used for these objects is mostly undefined. 1/3 is carved of elephant ivory, which goes probably for most of the unidentified pieces as well, since Gothic France traded ivory mostly coming from Africa. On the French influence on neighbouring countries like Germany, see Little, 1997; Randall, 1993: 10–16.

tric-trac boards and backgammon, as well as dice.[65] While there are scattered objects throughout the centuries (five to 10 objects each), the vast majority come from the 12th century with approximately 150 pieces (of which 67 pieces are from The Lewis Chessmen bequest alone, London BM).[66]

The early pieces from the 11th century are mostly chess pieces from Egypt or Sicily (BM 1862,0809.2, 1877,0802.8, 1881,0719.47, 1856,0612.4), England (BM 1863,0528.1, 1892,0620.1, 1865,1220.96), Pakistan (BM 1857,1118.55; 1857,1118.5) and Iran (**Figure 12**), and may point to a reflection of the origins of chess having been in and around old Persia. All of the early pieces are of undefined ivory, but given that in the 12th century walrus turned out to be the dominant material (112 walrus, five elephant), this should be presumed for the 12th century as well. For the 12th century, we are dealing mostly with chess pieces (78), but general draughts-pieces (56) and tric-trac (four) are also significant. Usually, game pieces have a predetermined appearance, albeit with variations, as they stand for a specific symbol. But there also exist a very few game

Figure 12: Figural Chess Piece, 11th–12th century, Saqqizabad (Iran), ivory, The Metropolitan Museum of Art (reproduced under Creative Commons license CC0).

[65] For an introduction to ivory pieces related to gaming, see Baker, 2023: 76–112.

[66] Following recent analysis, the Lewis Chessmen pieces are to be dated to the late 12th to early 13th century. Most of them are made of walrus ivory, while some rare pieces are of sperm whale teeth (Tate et al. 2011: 257). For their origin in Trondheim and their discovery on the Scottish coast, see Caldwell et al. 2009.

pieces related to literary figures that derive from mythology, the Old Testament or Fables (10), which are anchored in little round reliefs, for a game that apparently was a precursor of backgammon (**Figure 13**).[67] Chess pieces now originate mostly from Scandinavia (Norway, **Figure 1**), and from Western Islamic Lands, more precisely Spain (**Figure 14**). Chess pieces were not bound to the medium of ivory, and other early sets from the 12th century were made of stonepaste (attributed to Iran, Nishapur, MET), but ivory was a handsome and light medium that was obviously appreciated in many cultures. The immediate dispersion from Persia to Scandinavia shows the high level of exchange along the busy trade routes, and how easy it was especially for the medium of chess to be carried a long way. Some other early chess pieces were also found in Germany (Cologne) and France. The vast majority were carved from walrus ivory, with five from elephant ivory.[68] The other unspecified draughts-pieces are mostly from Germany (Cologne), and some are from England and Scotland.[69] One would suppose

Figure 13: Tric-Trac with Judith and Holophernus, 1140–1150, Normandy, elephant ivory with paint, Louvre (© 1999 RMN-Grand Palais (musée du Louvre)/Jean-Gilles Berizzi. Reproduced under the Louvre image copyright: Re-use free of charge for digital scientific and educational publications).

[67] See, for example, MET museum Accession Number: 1970.324.4 'Game Piece with Hercules Slaying the Three-Headed Geryon'. Other pieces are entitled: 'Game Piece with Menelaus and Companions Battling Proteus', 'Game Piece with the Blinded Samson Led by a Boy to the Philistine Temple of Dagon', and 'Game Piece with Stork and Fox', all at the Metropolitan Museum.

[68] On a Belgian/Flemish chess piece made of elephant ivory, see: Goffette et al., 2021.

[69] Gaming pieces from the 13th through 16th centuries are mostly chess related, and they are more diverse in their origins. Several pieces come from Germany and Egypt, with single pieces from countries like England, Scandinavia, France and Spain.

Figure 14: Chess Piece of a Queen, 12th century, Spain, walrus ivory, The Walter Art Museum (reproduced under Creative Commons license CC0).

that the majority were made out of walrus ivory, which was the preferred material in Scandinavia and the Middle East, the geographical areas most involved in producing gaming pieces, as the trade routes have shown. Indeed, elephant ivory occurred only occasionally (e.g. in Germany, MET 463705, 464024).[70]

Personal items: Caskets and Boxes

Caskets and boxes were a highly praised and very diffused luxury object, one of the most popular through centuries and countries. Their use in religious and secular scenarios was likewise manifold, as a container for reliquiae, gaming pieces, jewelry, and other precious objects. The most desirable were made of ivory, but given the vast demand for boxes they were likewise often made of bone. 'Bone, which could be polished to look like ivory, and painted and gilded, as ivory was, undoubtedly represented a practical as well as a cheap alternative to a prized and vanishing medium', writes Nuttall about boxes and caskets (Nuttall, 2010: 122). They belong to a category of luxury objects, like combs, where standardization and serialization processes were common and diffuse.

[70] The dataset would suggest that after the 12th century gaming pieces became rather rare, which is probably, once again, a misleading suggestion, based on the substantial gaming bequests to the museums.

As Nuttall explains, 'Repetition was common: although no two boxes are identical, and exact copying is rare, the same designs recur, with variety consisting in the different combinations of plaquettes rather than in pictorial invention' (Nuttall, 2010: 122).

Caskets and boxes are an interesting category of comparison because they are internationally popular throughout the centuries, and in the dataset, they occur in almost equal numbers in five museums (123 total).[71] Thus, they invite a closer look. The 27 examples from the 11th and 12th centuries comprise six items of solid ivory with fantasy animal ornaments from southern Italy, four of solid ivory from England showing figurative scenes (of which two are made from painted walrus ivory, Louvre OA 11342, OA 11343), and one from the Near East made of solid ivory and animal ornaments on a rectangular box (Louvre 08/11/1884). The biggest group of eight caskets from the Byzantine Empire are more diverse (one of elephant ivory, V&A 084215, the others unspecified: V&A 0347706, 089119. WAM 7841 and 19456. BM 1901,1230.1. Lou OAR 34. MET 464239). Some caskets of solid ivory show figurative scenes, like a very fine carving of an Old Testament scene from the story of Jacob and Joseph (BM 1901,1230.1, only one side panel extant), and the stories of Joseph, and Adam and Eve (WAM 1931-01-01). Caskets with profane topics show the stories of Hercules (Louvre OAR 34), warriors and dancers (MET 464239), or warriors in combat (WAM 19456, mixed ivory and bone, mounted on wood). In all these pieces, ivory seems to be the predominant material, which sometimes was mounted on wood. The box itself is mostly of rectangular shape, sometimes with a flat cover, sometimes with a more dominant roof or lid.

About 65 boxes come from the 13th and 14th centuries, of which 25 are of elephant ivory, while the majority are unspecified, and one is a composition of ivory and bone. The vast majority of boxes derive from France (40) (**Figure 15**), with Italy coming in second (13), while both countries are also the major hubs for elephant ivory caskets. The majority of the French caskets show figurative scenes taken from religious or profane literature.[72] Religious topics mostly show saints, or scenes with Christ or Mary, or biblical parables (like the prodigal son). Secular topics are mostly taken from Romance literature (e.g. the Romance of the Chatelaine de Vergy, anthologies of ancient mythology). The shape of the boxes is mostly rectangular, with some exceptions for round boxes used for liturgical purposes (Pyxis/Pyx. MET, for example 446818). Italian boxes of this time are almost exclusively from Sicily (15). The locally developed Siculo-Arabic style shows a decorative Islamic influence coming either through Islamic artisans working in Sicily, or

[71] BM = 18, V&A = 23, MET = 23, Louvre = 31, WAM = 24, and furthermore Rijks = 3.

[72] On French, Flemish and Netherlandish caskets, their courtly decoration, painting and gilding, see, for example, Randall, 1997; and Nuttall, 2010.

Figure 15: Casket with profane scenes of lovers, 1325–1360, France, elephant ivory, Louvre (© Musée du Louvre/Objets d'art du Moyen Age, de la Renaissance et des temps modernes. Reproduced under the Louvre image copyright: Re-use free of charge for digital scientific and educational publications).

from Christian artisans adapting the Islamic style.[73] This symbiosis developed a mostly ornamental decoration, or with stylized animals.[74] Another small round box was used for falconry (MET 471563). Other countries figure in with just one or two entries. An octagonal box from Spain around 1200 shows a decorative pattern with an ornamental inlay made of ivory, bone and wood, a technique and pattern common for Andalusian craftsmen influenced by Moroccan decorations (**Figure 16**). Two Egyptian boxes show interesting openwork, where the ornamental pattern has been carved out of the surface, so that the airy box becomes semitransparent (round mamluk box (BM 1891,0623.8), rectangular box (Louvre MAO 684)). Two round boxes from China in the Yuan dynasty have a linear decoration that look like pommel scrolls (BM 2018,3005.441.a-b, MET 40174). Interestingly, in both boxes the soft ivory shimmer has been stained brown (thereby alluding to the darker walrus or narwhal ivory).

About 30 caskets belong to the 15th and 16th centuries. Since elephant ivory became rarer then, it is present in only three examples. The range of countries is significantly higher, but mostly with only one or two examples.[75] The five boxes from France are along the lines of the earlier centuries, showing scenes from biblical or romantic

[73] On Islamic boxes, see: Randall, 1985: 149–161; Cutler, 2011: 15–37; Armando, 2017. Armando offers an overview of 320 Siculo-Arabic boxes and pyxides, considering their style, forms and decorative patterns. She proposes fewer workshops working for a broad range of clienteles.

[74] Some examples: three little round Pyx-boxes for e liturgical purposes containing the Host (WAM).

[75] China, Egypt, England, Belgium, Netherlands, France, Germany, India, Italy, Sierra Leone, Sri Lanka.

Figure 16: Octagonal Box, late 12th to early 13th century, Spain, ivory or bone, wood, paint, The Metropolitan Museum of Art (reproduced under Creative Commons license CC0).

literature. The 10 caskets from Italy dating to the 15th and 16th centuries show that south Italy is still on the scene, but Venice has become more prominent. Half of these caskets can be associated with the Embriachi family, the leading workshop for ivory carving in Italy (Florence and Venice) between 1370 to 1430, although most of the objects were actually made of bone (horse or cow bone, occasionally hippopotamus ivory), in combination with a wooden intarsia inlay.[76] Their caskets often served as a marriage gift, and could likewise present both sacred and profane topics. The profane topics were similar to the French and Flemish boxes of the 13th and 14th centuries, referring either to romance literature or biblical topics (examples: Susannah and the Elders is displayed on a BM 1878,1101.20 casket, the story of Griseldis (Louvre, **Figure 17**), of Paris (Louvre OA 125).[77] The box shapes are either rectangular or hexagonal.[78] The boxes of the Embriachi family offer a good example of a trans-European to Near East hybrid approach to styles. While the figurative decoration points to France and Flanders, the decorative patterns surrounding the figurative scenes are very similar to

[76] On the Embriachi family, see von Schlosser, 1899: 220–282 (catalog of objects); Trexler, 1978; Gaborit-Chopin, 1978: 172–174; Hegemann, 1988: 98–102; Martini, 2001; Tomasi, 2001; Tomasi, 2010 (with a description on the process of manufacturing and cutting costs by using bone and pre-manufactured modules, see pp. 217–232).

[77] It has already been proposed that the courtly imagery of the Embriachi caskets were close to the Parisian style (Tomasi 2003: 131, 124–139; Nuttall, 2010, 139).

[78] The datasets include surprisingly few of the Embriachi works, which at their time were quite widely distributed luxury objects, and easily recognizable because of their particular style.

Figure 17: Box with the story of Paris, ca. 1400, Embriachi family, Venice, bone, wood, inlay, Louvre (© 2002 RMN-Grand Palais (musée du Louvre)/Jean-Gilles Berizzi. Reproduced under the Louvre image copyright: Re-use free of charge for digital scientific and educational publications).

the Siculo-Arabic decorative, continous interlooping style, and they are comparable to boxes from south Italy, southern Spain, and Egypt.[79] Instead, the figurative scenes were put on individual pieces, which could then be combined into a broader narrative, with biblical or courtly scenes, which were influenced by the French caskets. Known as successful merchants working on a European level, the Embriachi family combined two very trendy styles to make a highly successful commercial product that could be manufactured *en masse* for wedding occasions, liturgicial purposes or else, and could be shipped from Venice throughout Europe.

Personal items: Sundials and compasses

With sundials and compasses we enter a different era of luxury items for professional use. As precise scientific objects, their primary purpose is the reliable calculation of

[79] On the appropriation of objects and styles regarding caskets, crossing cultural and religious boundaries between the Al-Andalus and Iberian Christian kingdoms in the 11th and 12th centuries, see, for example, Monteira. The author gives an example of an 11th century Islamic object *alla moresca*, then passing on into a different usage in Christian Romanesque art (Monteira 2022). This is one of many examples of objects and styles travelling and being appropriated by other cultures, sometimes centuries later.

time and space, to which the decorative part becomes a luxurious addition. In the 15th and 16th centuries, ivory sundials and compasses were usually small portable objects for the use of travelers that were easy to transport in a traveler's pockets (26 objects, mostly London BM). The simpler versions were made out of wood.[80] The early production of sundials and compasses seem to have grown out of writing tablets. Schewe and Davis have studied the history of writing tablets and sundials and labeled the intermediate version 'wax tabled-sundials'. They carried a sundial on the front and a writing tablet on the back of the object, probably dating to between 1431 and the mid-15th century (Schewe and Davis, 2019).

Sundials and compasses were often described as diptychs because of their foldable nature. Given their particular purpose, most of these objects are traceable to their workshop of origin, a rare circumstance for ivory items. The workshops in Germany, and especially in Nuremberg, were by far the best-known producers of these precise instruments, and several workshops—and several generations within these workshops—were active in the field (19). To these belonged various generations of the Hans Tucher family (Lou OA 101, BM 1871,1115.17; 1871,1115.18; 1867,0705.26; 1896,0212.2; 1888,1201.288; 1871,1115.19) (**Figure 18**), as well as the workshops of Paul Reinmann (BM 1871,1115.15; 1862,0809.4; 1871,1115.14; 1854,1211.1; 1888,1201.284) and Georg Hartmann (V&A O31103; BM 1894,0722.1 and 1900,1017.1). Some other cities had specialized artisans too: in Stuttgart (Jacob Ramminger, BM 1896,0808.1), Gundhalbing (Hans Graf, BM 1862,0809.3), and also in London (Charles Whitewell, BM 1854,0103.1).[81] In the given time period, sundials and compasses seem to have been the only case where ivory gets used for a professional or scientific purpose. Once again, it is probably the luxury aspect of an item that fits well in a pocket and is ready for transport which made the material well suited for this purpose. Their light weight and transportability had already been a benefit for other personal items, as well as for portable altars.

Evaluating the data lens as method

Looking at the earliest examples in the record for the 11th and 12th centuries, it becomes clear where the interest in ivory originated. Thirty Byzantine pieces and 14 Near and Middle Eastern pieces speak for a clear interest in those geographical areas. To these can be counted an additional eight pieces from Western Islamic countries and 41 from southern Italy, likewise influenced by south-eastern Mediterranean styles. On the other side, there figure 22 objects from England and hardly anything from France,

[80] All of the 26 pieces in this category are of undefined ivory quality. One should presume elephant ivory, given that the objects date to 15th- and 16th-century Europe, where this material was largely in use for delicate, decorative objects.

[81] On sundials and compasses, see, for example: Hegemann, 1988: 110–114; and Schewe and Davis, 2019.

Figure 18: Compass, 1590, Hans Tucher II or III, Nuremberg (Germany), ivory with paint, Louvre (© 2009 RMN-Grand Palais (musée du Louvre)/Jean-Gilles Berizzi. Reproduced under the Louvre image copyright: Re-use free of charge for digital scientific and educational publications).

Germany, or even Scandinavia. As always, the majority of objects is of undefined material (94), which are present in all areas. The 29 walrus ivories belong to objects mostly in England and some in Germany, whereas the 35 elephant ivories belong to Byzantine, Near Eastern, Spanish and southern Italian objects. Athough the Near and Middle East had their own history of elephants, which in ancient times were found from India to Syria and therefore had their own traditions of ivory carving,[82] in the timespan under discussion only the Indian elephants survived, and tusks were increasingly imported from African elephants as trading from and Islamization of these countries developed quickly. Nevertheless, probably already in the 11th century but testified for the 12th century, walrus ivory must have been widely available, as the manifold gaming pieces testify. They result from walrus tusks carved in the country of destination, as is witnessed by their different styles. The mentioned Ottoman sources of huge quantities of walrus tusk imports during the 15th and 16th century speak for an ongoing and far reaching exchange that lasted for several centuries.[83] While walrus received much

[82] For ancient Asian ivory carving, see: Collon, 1977.

[83] As mentioned, conclusions are drawn from a dataset that lacks much information. Most desirable would have been more information on eastern pieces.

ongoing attention in Scandinavia and Asia, the turn to elephant ivory in Europe was decisive at least from the 14th century onwards, and hardly ever turned back.

As we have seen, the dataset provides confirmation for long trading routes, and for cultural and artistic exchanges. Many influences moved from East to West, like gaming pieces carved of walrus ivory, luxury objects like combs and mirror cases, painting on ivory surfaces, ivory boxes and caskets with inlay decoration, and much else. Luxury items seemingly originated in the Gothic West, but were sometimes anticipated in the Near East. Once they arrived in Europe, however, they were much more homogenous in their decoration, and seemed in essence to be a Western Gothic style. These general tendencies are easier to demonstrate with the macroscopic approach through these data studies than with the traditional approach (as done, for example, by Koechlin and others).

The nine museums chosen for this analysis through the data lens can offer a variety of insights into the distribution of ivory qualities, object categories, objects in time and place, the qualities of the materials, acquisition policies by museums, and much more.[84] While it is desirable to take a meta-approach to all of these questions, and to investigate more than one museum's holdings alone, the results vary significantly based on the choice of museums.[85] For example, it can make a significant difference if one includes a museum from central Europe, North America, Scandinavia, Africa, or the Near or Far East. In the end, each museum has its own collection strengths as derived from acquisitions policies, bequests, or simply due to the objects available in a given area. A thorough and more reliable analysis would therefore require a much larger and more balanced museum data pool, with access to more museums and to a broader range of internal data. This is, however, not yet possible.[86] Repeating the same analysis in less than five years' time would probably deliver a much clearer

[84] The underlying dataset could have also offered other modes of analysis, for example, going more deeply into acquisition and bequest policies, or into aspects of object decoration. Furthermore, the method applied here is not the only way to address museum data through query endpoints. While there are still all-too-few publications on this topic, I can point to this example: Angelis and Kotis, 2021 (this project converted museum data taken from GitHub, modelling these into RDF data, to make them available for SPARQL queries).

[85] As a reminder: the choice of these nine museums was driven by the availability of query endpoints or available datasets for querying.

[86] Since 2010, the 'Gothic Ivory Project' at the Courtauld Institute in London offers a museum-overarching approach to ivories in public and private collections around the world. As a very useful research tool, it provides a description, provenance, bibliography and several images for each item, as well as some helpful tools for research to navigate through and work with this information within the website. It does not, however, offer any data querying possibilities or export functions through APIs. It works therefore like many public museum websites, where one can find information on one object, without any access to the dataset for other querying methods of the entire dataset (see http://www.gothicivories.courtauld.ac.uk, last accessed 20.01.2025).

picture, once more museums open up the data behind their objects. The vast majority of museums still do not provide access to their data, beyond what they propose on their museum's webpage. The museums currently opening up their data are in part reworking their former offerings into something much more easily accessible. The difficulties surrounding a query endpoint of museums are discussed in the introduction to this volume of collected essays.

This new data-driven query method through museum endpoints that I have presented has obvious advantages and disadvantages. On one side, to the clear advantages belong the possibility of researching through several museum holdings at the same time (once the dataset is combined and modeled), to query museum objects on view and on deposit all together, and to be able potentially to provide insights into a given category from a very broad perspective, but also to look for objects hidden in storage. To the disadvantages belong the fact that data is changeable, and that the selection of museums is driven by the availability of a query structure.[87] Both facts lead to the disturbing circumstance that any research done today, in terms of quantity, percentages, attributions, etc., might look quite different in a short to medium timeframe. Relying only on the dataset without a knowledge of the objects themselves could easily lead to false or misleading results. Where the current dataset is particularly problematic are fields like: the quantity and percentage of elephant ivory as compared to walrus; the quantity of ivory carved at the place of origin as compared to the place of destination; the quantity of objects in each category (religious/profane) and their sub-categories, and many more. It would be highly desirable to include much more ivory originating in the Byzantine Empire, in Scandinavia, the Ivory Coast and the Near East, where only some figures appear among the large number of objects, which are highly Eurocentric. This would also lead to better ideas about gaming pieces, boxes and caskets, just to mention a few. Currently, the dataset could have provided better results for questions on acquisition policies or provenances, both topics on which the article did not wish to focus. Nevertheless, the presented research still offers many new insights into the topic of medieval and early modern ivories in Europe, Africa and Asia, in terms of distribution on a large scale, as well as on many individual pieces hidden in different collections and storage spaces, which often remain out of sight when compiling standard reference works. Indeed, it seems especially intriguing when one is not dealing with the already well-known masterpieces, but rather with everyday objects, less well-known crafts, or international comparisons.

[87] This method also excludes the physical study of an object, beyond the availability of photos queried through the same channels. This, of course, can and should be added by the researcher for at least a limited number of objects to get a better idea of the materials, sizes, conditions etc.

Appendix: Object IDs

Less than five objects did not produce an Object ID with the query.

London, British Museum (BM = 695 objects)

1989,0514.1; 1902,0625.1; 1904,0624.2; 1903,0514.7; 1903,0514.6; 1978,0502.4; Af1979,01.7016; Af1979,01.7017; Af1961,09.2; Af1979,01.4552; Af1921,0615.1; Af1979,01.4560; Af1979,01.4561; Af1921,0615.2; Af1979,01.4551; Af1922,0311.1; Af1944,04.77; Af1954,23.407; Af1939,07.33; 1941,1007.1; Af1897,-.519; Af1922,0313.3; Af1897,-.521; Af1949,46.180; Af1897,-.522; Af1898,0623.1; Af1984,19.367; Af1944,04.58; Af1949,46.173; Af1949,46.172; EA82027; EA80270; Af1966,03.4; 1947,0712.438; 1974,1002.1; 2018,3005.441.ab; 1874,0302.5; 2018,3005.453.ab; 1904,0624.1; Af1954,23.371; Af1954,23.373; Af1954,23.372; EA77739; EA80241; EA80269; EA80242; EA77689; EA80275; 2018,3005.217; 2018,3005.226; 2018,3005.237; 2018,3005.222; 2018,3005.251; 1831,1101.145; 1892,0216.25; 1892,0801.47; 1855,1201.37; 1958,0402.2; 1856,0623.166; WB.217; 1885,0804.13; 1878,1101.20; 1878,1101.41; 1958,0402.1; 1878,1101.33; 1831,1101.141; 1831,1101.143; 1831,1101.142; 1831,1101.129; 1831,1101.135; 1831,1101.132; 1831,1101.133; 1831,1101.128; 1831,1101.126; 1831,1101.104; 1831,1101.108; 1831,1101.111; 1831,1101.78; 1831,1101.123; 1831,1101.119; 1831,1101.82; 1831,1101.125; 1831,1101.118; 1831,1101.107; 1831,1101.115; 1859,0516.1; 1831,1101.106; 1831,1101.121; 1831,1101.120; 1831,1101.117; 1831,1101.105; 1831,1101.85; 1831,1101.86; 1831,1101.80; 1831,1101.100; 1831,1101.95; 1831,1101.89; 1831,1101.93; 1831,1101.84; 1860,0928.17; 1883,0621.84; 1883,0621.81; 1857,1118.55; 1883,0621.63; 1862,0809.2; 1863,0528.1; 1888,0720.1; 1877,0802.8; 1881,1114.1; 1831,1101.138; 1831,1101.136; 1831,1101.137; 1831,1101.130; 1831,1101.131; 1831,1101.140; 1831,1101.134; 1831,1101.127; 1831,1101.139; 1831,1101.144; 1991,0708.1; 1831,1101.88; 1831,1101.83; 1831,1101.116; 1831,1101.112; 1856,0612.3; 1831,1101.110; 1831,1101.102; 1831,1101.81; 1831,1101.122; 1831,1101.79; 1831,1101.113; 1831,1101.109; 1831,1101.124; 1831,1101.103; 1831,1101.114; 1831,1101.87; 1831,1101.97; 1831,1101.94; 1831,1101.90; 1856,0623.137; 1831,1101.98; 1831,1101.91; 1831,1101.96; 1831,1101.99; 1831,1101.92; 1831,1101.101; 1867,0709.2; 1883,0621.86; 1881,0719.47; 1856,0612.2; 1892,0620.1; 1856,0612.4; 1883,0621.87; 1857,1118.56; 1857,0804.34; 1980,0730.1; 2004,1216.1.a-ii; 2018,3005.480; Af1958,10.2; 1883,0109.1; 1957,1002.1; 1916,0403.1; 1894,0518.30; SLMisc.565; OA.1412; 1877,0116.35; 1894,0518.29; 1856,0701.1501; 1856,0623.29; 1856,0623.114; 1896,0808.1; 1921,0625.1; Af1939,33.1.a-b; Af1918,0413.1; 1858,1110.1; 1874,0302.3; 1850,0826.1; 1856,1218.1; 1856,0623.32; 1903,0323.1; 1981,1101.1; 1868,0805.27; 1856,0623.34; 1856,0623.33; 1896,0617.1; 1894,0722.1; Af1930,0616.1; 1888,0719.61; 1921,1101.301; 1921,1101.300; 1921,1101.299; 1885,0805.1; 1856,0623.68; 1971,0501.1; 1856,0623.71; 1970,0303.1;

1856,0623.91; 1881,0802.9; 1856,0623.67; 1919,0710.3; 1856,0623.70; 1856,0623.85; 1856,0623.87; 1856,0623.78; 1900,1013.1; 1894,0309.22; 1894,0309.23; 1894,0309.21; 1878,1101.36; 1856,0509.3; 1856,0623.83; 1856,0623.84; 1856,0623.36; 1856,0623.43; 1856,0623.65; 1856,0623.89; 1856,0623.74; 1856,0623.72; 1856,0623.52; 1856,0623.69; 1881,0802.8; 1943,0401.1; 1856,0623.63; 1878,1101.38; 1900,1013.2; 1878,1101.37; 1856,0623.77; 1856,0623.50; 1856,0623.86; 1856,0623.51; 1856,0623.75; 1856,0623.59; 1856,0623.80; 1881,0802.7; 1856,0623.76; 1856,0623.58; 1855,1201.34; 1978,0502.5; 1856,0623.79; 1856,0623.81; 1856,0623.64; 1856,0623.82; 1919,0710.1; 1856,0623.73; 1958,1006.2414; 1871,1115.17; 1871,1115.18; 1871,1115.15; 1862,0809.4; 1871,1115.14; 1867,0705.26; 1854,1211.1; 1896,0212.2; 1877,0521.23; 1900,1017.1; 1888,1201.288; 1871,1115.19; 1987,0305.1; 2018,3005.526; 2018,3005.527; 1831,1101.149; 1892,0801.28; 1908,0715.1; 1892,0801.30; 1892,0801.32; 1892,0801.37; 1892,0801.31; 1892,0801.26; 1892,0801.25; 1892,0801.40; 1892,0801.33; 1892,0801.29; 1892,0801.41; 1892,0801.19; 1892,0801.35; 1892,0801.43; 1892,0801.18; 1961,1101.2; 1929,0604.1; 1891,1120.1; 1865,1220.96; 1831,1101.148; 1892,0801.27; 1859,0715.1; 1831,1101.146; 1831,1101.152; 1857,0917.2; 1923,0206.1; 1831,1101.153; 1831,1101.154; 1885,1010.3; 1871,1115.1; 1857,0917.1; 1892,0801.36; 1892,0801.24; 1892,0801.23; 1892,0801.46; 1892,0801.20; 1892,0801.45; 1892,0801.44; 1892,0801.42; 1892,0801.38; 1892,0801.34; 1831,1101.150; 1831,1101.147; 1951,0706.3; 1831,1101.156; 1910,1012.1; 1894,0309.19; 1853,0214.1; 1831,1101.159; 1879,1101.1; 1831,1101.155; 1831,1101.151; 1831,1101.157; 1831,1101.158; 1909,0614.1; SLMisc.2021; 1932,0307.6; 2018,3005.13; 2018,3005.187; 1952,1219.9; 2018,3005.182; 1910,1107.4; 1910,1107.5; 2018,3005.188; 1952,1219.7; 1952,1219.11; 2018,3005.14; 1971,1001.1; 2018,3005.30.a-b; 2018,3005.180; 1945,0420.2; Af1953,07.1; 1893,1101.17; 2018,3005.18; Af1905,1201.5; 2018,3005.51; Af1985,15.5; 1975,0301.1; 2018,3005.62; 1972,1213.1; 2018,3005.11; 1885,0804.9; 2018,3005.21; Af1944,04.56; 1945,0726.1; SLMisc.1120; 2018,3005.72; 2018,3005.58; 2018,3005.16; 1952,1219.6; Af1965,04.1.a-b; 1883,1016.1; 2018,3005.186; 2018,3005.64; 1937,0716.165; 1945,0420.3; 1952,1219.8; 1952,1219.10; 1972,1213.2; 2018,3005.67; 2018,3005.57; Af1949,46.169; Af1954,23.374; 1856,0623.31; 1856,0623.30; Af1928,-.148; Af1950,33.1; Af.7845; 1874,0302.7; 1921,1101.285–298; Af1964,07.1; Af1963,04.1; 1952,1219.29; WB.9; 1985,1101.792; 1913,0501,0.77; 1878,1230.817; 1895,0319.2; 1862,0809.3; 1854,0103.1; 1858,0616.1; 1888,0719.128; Af1979,01.3156; Af.7009; 1975,0401.1; Af1898,1212.1; 1958,0730.11.a-b; 1854,1130.50; 1867,0320.18; 1856,0701.1506; 1852,0625.1; As1939,04.118; As1939,04.72; 1891,0623.8; Af1867,0325.1.b; Af.7398.b; Af.5117.b; 1924,1020.1; 1924,1020.2; SLAntiq.804; 1894,0722.2; 1921,1017.1; 1856,0623.134; 1856,0623.135; 1856,0623.109; 1856,0623.103; 1856,0623.101; 1885,0804.6; 1856,0623.105; 1888,0208.1; 1856,0623.112; 1879,0203.1; 1902,0423.4; 1856,0623.111;

1856,0623.108; 1856,0623.107; 1856,0623.113; 1856,0623.106; 1856,0623.110; 1856,0623.104; 1856,0623.125; Af1921,0214.3; Af1959,14.2; 1887,0524.6; 1979,0701.1; 1923,1205.3; OA+.1302; Af.9037; 1943,0710.2; Af1910,0618.4; 1881,1210,0.1207; 1903,0514.3; 1856,0623.35; 1885,0804.5; 1943,0710.22; 1943,0710.9; 1894,0616.1; 1856,0623.119; 1856,0623.42; 1856,0623.26; 1889,0311.1; 1856,0623.47; 1892,1102.2; OA.1340; 1943,0710.10; 1888,0411.1; 1943,0710.14; 1943,0710.16; 1856,0623.92; 1880,0607.4; 1943,0710.4; 1943,0710.20; 1901,1230.1; 1880,0607.1; 1856,0623.46; 1943,0710.25; 1886,0702.5; 1903,0514.5; 1856,0623.24; 1903,0514.4; 1856,0623.27; 1892,1102.1; 1943,0710.8; 1943,0710.6; 1943,0710.24; 1943,0710.12; 1943,0710.23; 1943,0710.11; 1943,0710.17; 1878,1101.39; 1877,0116.38; 1856,0623.48; 1943,0710.18; 1874,0302.6; 1943,0710.26; 1856,0623.22; 1943,0710.19; 1943,0710.3; 1943,0710.13; 1875,0617.1; 1943,0710.7; 1894,0309.20; 1856,0623.61; 1856,0623.62; 1943,0710.15; 1856,0623.28; 1943,0710.5; 1856,0623.45; 1856,0623.21; 1880,0607.3; 1856,0623.23; 1903,0514.2; 1856,0623.19; 1880,0607.2; 1878,1101.34; 1856,0623.94; 1885,0804.8; 1856,0623.93; 1856,0623.60; 1894,0309.25; 1878,1101.35; 1870,0811.1; 1967,0401.1; Af1910,0513.1; 1921,1101.264; 1986,0401.1; Af1954,23.787; 1891,0523.1; OA+.1449.1; 1921,0608.1; OA+.1452.3; OA+.1450.2; OA+.1445; OA+.1451.1; 2018,3005.551; OA+.1450.1; 1921,0407.1; 1991,0401.1; OA+.1443; 1978,0701.1; OA+.1452.1; 1980,1201.1; OA+.1446; 1978,0502.1; OA+.1447; OA+.1449.2; OA+.1452.2; OA+.1448; 1978,0502.2; 1995,1006.1; 1887,1025.14; OA+.1451.2; 1888,1201.284; SLMisc.1879; 1923,1205.4; 1856,0623.41; 1986,0604.1; 1856,0623.40; 1861,0416.2; 1855,1031.1; Af1944,04.57.a-b; 1879,0203.2; Af1867,0325.1.a; Af1879,0701.1; Af1856,0623.162.a-c; Af.5117.a; Af.7398; Af,+.170; Af1878,1101.48.a-c; Af1981,35.1.a-b; Af1949,46.177; Af.7398.a-b; Af1952,18.1.a; 1944,1001.17; Af1944,04.60; Af1954,23.390; 1926,1007.1; 1885,1010.4; 1856,0623.145; 1881,0308.1; Af1954,23.316; Af1954,23.317; Af1949,46.170; 1856,0623.153; SLSeals.110; 1982,0701.2; 2018,3005.197; 1883,0712.2; 1982,0701.1; 1944,0601.1; 1881,0404.1; 2018,3005.198; 2019,8032.1; 1854,1118.1; 1872,0329.71; 1857,1013.7; AF.942; Af1856,0623.164; Af,+.5929; Af1979,01.3155; Af1979,01.3154; Af1856,0623.163; 1882,1211.1; Af.9184; Af1910,0618.5; 1878,1101.78; 1955,0421.1; 1891,1013.1; 1856,0623.147; 1856,0623.141; 1856,0623.146; 1856,0623.148; 1858,0428.1; 1856,0623.143; 1856,0623.152; 1856,1213.9; 1851,0715.1; 1856,0623.150; 1856,0623.38; 1980,0102.1; 1856,0623.156; 1978,0502.3; Af1954,23.247; OA.1338; 1890,0209.5; 1957,1014.2; Af1949,46.166; Af1903,1216.1; Af1944,02.2; Af1995,05.1; Af1903,1216.2; 1856,0623.37; 2018,3005.282; 2018,3005.256; 1920,0415.6; 1862,0422.1; 1885,0804.15; 2018,3005.257; 1862,0422.2; 1992,0525.85; 1992,0525.111; 1992,0525.109; 1992,0525.108; 1992,0525.98; 1992,0525.52; 1947,0418.5; 1992,0525.57; 1992,0525.42; Franks.1815.1; Franks.1815.25; Franks.1815.71; 1947,1217.36.a-b; 1947,0418.22;

Franks.1815.88; 1959,1202.1; Af1920,1106.24; HG.285; 1888,0208.2; 1921,0216.27; 1856,0623.54; 1861,0416.1; 1856,0623.56; OA.1343; 1926,0712.1; 1856,0623.53; 1890,0217.1; 1856,0623.55; 1856,0623.116; 1856,0509.4; Af1954,23.321; Af1954,23.320; Af1954,23.323; Af1954,23.324; Af1954,23.327; Af1954,23.322; Af1954,23.325; Af1984,19.663; Af1984,19.234; Af1954,23.326; Af1944,04.59; Af1954,23.319; Af1954,23.330; Af1954,23.328; Af1954,23.329; Af1984,19.121; Af1958,10.1; Af1922,0405.2; Af1898,1022.1; Af1922,0405.3; Af1922,0405.4; Af1898,1022.3; Af1922,0405.1; Af1898,1022.2; 1888,1217.1; 1856,0317.1; 1856,0509.2; 1893,0901.1; 1881,0802.10; 1890,0809.5; 1877,0706.2; 1902,1117.4; 1856,0623.96; 1894,0309.24; 1856,0623.98; 1914,0220.1; 1856,0623.97; 1878,1101.40; 1856,0623.95; 1881,0802.11; 1881,0802.12; 1877,0706.1; 1856,0623.100; 1856,0623.99

London, Victoria & Albert Museum (V&A = 320 objects)

O323109; O102866; O106455; O166114; O192895; O169173; O89523; O137817; O137813; O130100; O130040; O130034; O129351; O113788; O113786; O70091; O73082; O72960; O72930; O70467; O299539; O92607; O89065; O88454; O88315; O89170; O73091; O88284; O87607; O25028; O72949; O72932; O62732; O155464; O109003; O94293; O94166; O72938; O86577; O107623; O448918; O72533; O120000; O118924; O107370; O107355; O107303; O106938; O106934; O106819; O106784; O106783; O106756; O106753; O106479; O106475; O106470; O106464; O106462; O106451; O106445; O106437; O106416; O106413; O106411; O106370; O106369; O106326; O106323; O106310; O166122; O88471; O1109672; O106937; O16094; O88329; O482519; O89075; O88880; O88857; O88839; O88818; O88761; O88478; O88363; O88283; O87314; O87228; O49852; O192268; O166401; O88470; O172039; O86573; O86075; O106744; O350111; O350094; O349395; O238238; O83203; O313472; O313471; O313470; O313469; O313380; O313369; O313363; O312978; O312926; O312923; O312922; O312921; O312917; O312913; O312912; O312911; O312910; O312909; O312908; O312907; O312905; O312904; O312903; O312902; O312901; O312887; O312886; O312885; O312884; O312883; O312882; O312881; O312880; O312878; O312871; O312870; O312869; O312868; O312867; O312866; O312470; O312469; O312468; O312382; O312381; O312380; O312379; O312378; O312377; O312375; O311944; O311943; O311941; O311940; O311939; O310804; O310803; O166720; O166589; O166389; O166285; O166134; O166126; O166123; O166121; O166117; O166109; O166105; O165191; O165103; O163672; O159071; O156254; O103075; O103047; O103034; O166263; O102947; O165106; O102749; O102745; O102743; O102663; O152503; O106709; O102611; O73962; O314149; O106408; O88181; O88299; O165238; O89462; O107301; O89157; O88415; O88208; O111094; O106461; O87519; O88657; O166879; O88481; O106431; O88310; O88421; O88207; O313757; O87294; O111078; O88345; O88209; O89248; O88865; O106481; O88699; O88177; O72525; O88282; O88416; O88473; O106808; O89172;

O165105; O299540; O347706; O166591; O130510; O128913; O493367; O106797; O166137; O92681; O88369; O88292; O87441; O40562; O72558; O68987; O87291; O94171; O93335; O93178; O92776; O92701; O92636; O92605; O88297; O1260624; O186150; O184927; O183867; O166253; O166254; O166252; O298522; O102796; O92557; O192564; O495172; O64365; O106360; O88897; O89119; O89092; O88227; O88667; O88605; O165111; O493364; O88301; O90898; O96516; O381822; O172028; O88414; O311030; O166120; O39051; O7684; O154419; O106307; O151872; O148209; O251465; O176869; O168748; O181350; O369079; O448952; O312914; O312155; O153456; O312156; O129883; O126756; O231050; O93882; O92616; O130961; O166255; O92588; O74851; O120162; O94330; O88679; O249005; O72925; O96379; O70459; O72850; O69982; O92726; O93887; O312906; O166588; O165107; O166111; O84215

Amsterdam, Rijksmuseum (Rijks = 43 objects)

NG-NM-12397; AK-RAK-2004-1; BK-2003-6; BK-1992-27; BK-14390; BK-NM-7342; BK-NM-7357; BK-NM-630; BK-NM-631; BK-NM-11156; BK-NM-5778; BK-NM-7352; BK-NM-1282; BK-NM-632; BK-NM-3893; BK-NM-2306; BK-NM-7343; BK-NM-12384; BK-NM-122; BK-17226; BK-15622; BK-1992-28; BK-2013-6; BK-2012-22; BK-2012-26; BK-2008-69; AK-MAK-190; AK-MAK-724; BK-NM-625; BK-NM-9373; BK-NM-7356; BK-16991; BK-NM-82; BK-NM-3091-A; BK-NM-7355; BK-VBR-163; NG-NM-2813; BK-2014-11; BK-NM-12906; BK-1953-7; BK-NM-14307; AK-MAK-724-2; BK-16629

Baltimore, Walters Art Gallery (WAM = 190 objects)

74; 837; 1036; 1391; 1432; 1553; 1754; 2291; 2384; 2430; 2516; 2633; 2702; 3053; 3901; 4045; 4357; 5036; 5780; 5823; 6176; 6180; 6554; 6861; 7148; 7509; 7841; 8196; 8656; 8962; 9494; 9704; 9811; 9815; 10149; 10230; 10459; 10503; 10612; 10633; 10933; 11229; 11289; 11706; 11902; 12238; 12384; 12540; 13024; 13267; 13411; 13739; 14619; 14936; 15153; 15286; 15588; 15917; 16123; 16990; 17137; 17158; 17360; 17493; 17517; 18211; 18327; 18374; 18441; 91757; 19364; 19456; 19588; 19932; 19971; 20030; 20633; 20837; 20947; 21519; 21591; 21790; 22120; 22320; 22567; 22769; 23081; 23291; 23356; 23462; 24067; 24336; 24342; 24521; 24916; 25021; 25050; 25537; 25623; 25829; 26441; 26467; 26539; 26562; 26738; 27418; 27619; 27728; 27845; 28247; 28688; 29026; 29065; 29660; 29773; 29848; 30139; 30221; 30605; 30606; 31132; 31343; 31438; 31901; 32105; 32365; 32870; 33123; 33458; 34068; 34228; 34597; 34671; 34937; 34959; 34963; 35131; 35187; 35411; 35503; 36021; 36407; 36489; 36652; 36821; 37105; 37260; 38631; 39044; 39333; 39550; 40392; 40456; 32960; 31316; 28369; 26909; 20901; 13494; 18126; 4561; 30473; 32234; 78387; 3661; 101335; 977; 1568; 3312; 3632; 3772; 5368; 6359; 9099; 9243; 19028; 19461; 21835; 25905; 27498; 30266; 31536; 32311; 32419; 32520; 35782; 36674; 36686; 37527; 39888

New York, Metropolitan Museum (MET = 498 objects)

24953; 318622; 464306; 464236; 24676; 467691; 23197; 467741; 202716; 466045; 466105; 464702; 464220; 464299; 464360; 316442; 464156; 466289; 464443; 472935; 464233; 464125; 202612; 475487; 464699; 21967; 464300; 464298; 467367; 25164; 42012; 464160; 464224; 463513; 470305; 464148; 464179; 468354; 464226; 464455; 464232; 446990; 471975; 467690; 467733; 464248; 467737; 464026; 464295; 464137; 463674; 39635; 464704; 464225; 464278; 464223; 464221; 466149; 464131; 464294; 464139; 464234; 27388; 464239; 27389; 469844; 466161; 464418; 464339; 464025; 467643; 464039; 464291; 464290; 467774; 467773; 464154; 39639; 464287; 464350; 464520; 464531; 42088; 468059; 39623; 463705; 39880; 309900; 464024; 42014; 463641; 464231; 464227; 466114; 464476; 464251; 467742; 464158; 469712; 464288; 464169; 844002; 464012; 468339; 470346; 464330; 479663; 479733; 464047; 466056; 469714; 38516; 65605; 467369; 193644; 33782; 196346; 32221; 199649; 475490; 475489; 444812; 471976; 503043; 187641; 33766; 33748; 503951; 470149; 452380; 471919; 476545; 469912; 33770; 33773; 33769; 445045; 445049; 445048; 445047; 445065; 471972; 445084; 445046; 471851; 451949; 471980; 683963; 445089; 445090; 451948; 470005; 445050; 445037; 445026; 453497; 454675; 445033; 445032; 445034; 445038; 445031; 469932; 469906; 463612; 32288; 479682; 471563; 446986; 446818; 469719; 191872; 446985; 467481; 199648; 24313; 469830; 63088; 189228; 460281; 446989; 25157; 445085; 450745; 500554; 464279; 452619; 452500; 445035; 445116; 72269; 467384; 464296; 464269; 467476; 464046; 501767; 196591; 22831; 203989; 33783; 65587; 463983; 330099; 467731; 653244; 464262; 464159; 464268; 39636; 479664; 464136; 38353; 38536; 193478; 38576; 64926; 195120; 209015; 193479; 196600; 196599; 196726; 466267; 34077; 464168; 25138; 33784; 312331; 463493; 464167; 464247; 464257; 464246; 464065; 464135; 464134; 464132; 203994; 467777; 464174; 464150; 464192; 464282; 464281; 466055; 467620; 41976; 41983; 464228; 464098; 464153; 464297; 464147; 464110; 464276; 44687; 466073; 464274; 464259; 467395; 464054; 468683; 203995; 466265; 203996; 316611; 316612; 464244; 191740; 467470; 467473; 468684; 464264; 464161; 463536; 464245; 464087; 464272; 464289; 467471; 467479; 467478; 467480; 464130; 466054; 464265; 467694; 312810; 312808; 464255; 464252; 464253; 464277; 467475; 479089; 464118; 27624; 196701; 196720; 471458; 319465; 317828; 312730; 203005; 25137; 33501; 41933; 464260; 191741; 464243; 40174; 464275; 464151; 464149; 41929; 41931; 41930; 41928; 464258; 467477; 464280; 748355; 467372; 464263; 463537; 467469; 464155; 464198; 464157; 464293; 464076; 467472; 467986; 464261; 464292; 464283; 467474; 464266; 467732; 464256; 464133; 463397; 468580; 445027; 467377; 464273; 312798; 467378; 34156; 883968; 445056; 33084; 317825; 471981; 314510; 25129; 639757; 27529; 32584; 34002; 32696; 32692; 32674;

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Paris, Louvre (Louvre = 359 objects)

E 14285; E 14288; E 32596; E 14284; E 14287; E 14286; OA 5646; MRR 199; OA 2598; OA 140; OA 2585; OA 112; A 2772; MRR 163; OA 182; OA 10008; OA 2759; OA 12101; OA 11205; OA 148; OA 12373; OA 6261; OA 11331; OA 10963; OA 2008; OA 2592; OA 10964; OA 2009; OA 5541; OA 11394; OA 2010; OA 2591; OA 2593; OA 7461; OA 115; OA 2753; OA 6701; MAO 684; OA 6016; MR 377; MRR 425; OA 106; OA 2761; OA 6268; OA 7280; OA 7761; OAR 383; OA 11817; OA 2765; OA 89; MRR 197; OA 85; OA 8270; OA 7869; OA 180; OA 7760; OA 3988; MRR 430; OA 86; OA 10960; OA 2756; MRR 162; OA 3360; OA 12521; MRR 197 A; MRR 197 B; RFML.OA.2018.5.1; RFML.OA.2018.6.1; RFML.OA.2018.7.1; AD 10566; OA 94; OA 352; OA 3456; OA 2745; OA 4069; OA 6267; OA 7272 A; OA 7491; OA 7763; OA 9356; OA 10006; OA 10007; OA 10959; OA 11096; OA 6933; OA 10978; OA 9355; OA 7764; OA 7762; OA 117; OA 7283; OA 143; OA 176; OA 7274; OA 2764; MRR 429; OA 2771; OA 2586; OA 118; OA 10958; OA 10011; OA 7272 B; OA 12517; OA 12516; OA 7275; OA 12543; OA 104; OA 2596; OA 2603; OA 2762; OA 2763; OA 11367; OA 3361; OA 11738; OA 144; OA 10957; OA 11195; OA 7777; MRR 78; OA 7281; OA 96; OA 2757; OA 6455; OA 10012; OA 2597; OA 2755; OA 93; OA 7277; OA 7276; OA 7279; OA 163; OA 145; OA 109; OA 6262; OA 5542; OA 136; OA 5537; OA 7270; OA 12522; RFML.OA.2022.2.1; OA 131; MAO 396; OA 7460; OA 7882; OA 156; OA 6934; OA 9331; OA 12442; MAO 441; S 276; OA 10005; OA 10147; OA 9490; OA 6266; OA 2775; OA 272; OA 2742; OA 9957; OA 4071; OA 6265/1; OA 5017; OA 8262; MAO 221; OA 6265/2; OA 6649; OA 7459; OA 10146; OA 514; MRR 7; OA 2607; OA 11342; OA 178; OA 11113; OA 116; OA 11343; OA 122; OA 130; LP 2714; OA 103; OA 4089; OA 10925; MRR 195; OA 11153; OA 107; OA 2758; OA 7278; OA 2595; OA 2599; OA 2744;

OA 7268; OA 9959; OA 7308; OA 3935 A; OA 3935 B; AD 4342; MRR 424; OA 7007; OA 11168; OA 11269; OA 105; OA 3935; OA 2582; OA 6932; OA 2767; OAR 381; OA 12208; OA 10010; OA 7765; OA 9960; OA 2601; OA 3935 C; OA 2584; OA 6332; OA 7271; OA 7759; OA 9330; OA 10002; OA 11042; OA 11221; OA 119; OA 108; MRR 813; OA 6931; LP 615; OA 2583; OA 10428; MRR 77; OA 181; OA 633; OA 7507; RFML.OA.2018.24.1.1; OA 7267; OA 139; RFML.OA.2018.24.1.2; OA 12380; OA 10004; OA 2760; OA 9958; OA 11328; OA 129; OA 2746; OA 11228; OA 10009; OA 2743; OA 11167; OA 4085; OA 11961; OA 2769; R 873; OA 6017/5; OA 127; OA 497; OA 6340; OA 6017/6; OA 6076; ML 131; OA 12538; OA 2581; OA 166; OA 11128; OA 6017/9; OA 114; OA 12319; MRR 93; OA 6017/7; OA 152; OA 6017/8; OA 2600; OA 2588; AC 866; OA 9443; OA 11399; OA 498; OA 146; OA 7463 a, b; OA 4052; OA 170; OA 11755; OA 11150; MRR 194; MRR 427; OA 11227; OA 11776; OA 7778; OA 7462 a; OA 7462 b; OA 52; OA 11097; R 877; OA 7504; OA 2606; OA 6087; OA 157; OA 4063; RFML.OA.2018.12.1; OA 10901; OA 239; OA 9961; MRR 426; MRR 19; RFML.OA.2018.57.1; OA 7465 e; OA 7465 f; OA 7350; OA 12537; OA 4066 a; OA 3114; OA 4066 b; ML 132; HI 5; MRR 79; AD 7673; MRR 423; OA 6071; OA 12481; AA 170; OA 7465 i; OA 2594; MR 379; OA 7357; OA 113; OA 10003; MAO 1229; OA 4064; OA 3242; MRR 191; OA 7465 g; OA 7465 h; OA 7269; OA 4067 a; OA 4067 b; OAR 343; AA 169; OA 125; OA 6331; OA 6331 1; OA 11046; OA 6331 2; OA 6331 3; OA 6331 4; OA 3455; OA 500; OA 57; OA 501; MRR 428; OA 2587; OA 11332; MRR 303; OA 3448; MR 416; OA 4065; MRR 82; OA 2589 C; OA 2589; OA 2589 A; OA 2589 B; OA 3921; OA 58; OA 3922

Pittsburgh, Carnegie Museum of Art (CMA = 5 objects)

27.10.475; 52.3.1; 56.3.1; 63.15.2; 89.27.2

Williamstown, Massachusetts, Williams College Museum of Art (WCM = 4 objects)

1693; 1796; 1844; 2861

Cambridge, MA, Harvard Arts Museum (HAM = 9 objects)

1950.125.52.B; 1997.88.A; 1978,474; 1946,56; 1959,137; 1952,95; 1944,39; 1931,33; 601,1928

Competing Interests

The author of this article is also the editor of the special collection, and has been kept entirely separate from the peer review process for her article.

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