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The autumn of mediaeval portolan charts. Cartometric issues

Keywords: Portolan charts; Francesco Beccari; Cartometry; Latitude Chart

Summary

This contribution represents a focused insight within a larger research project dealing with the Ottoman nautical atlas of Piri Reis: the Kitab i Bahriye (1521 and 1525-1526). Taking as a point of reference the Ligurian Sea, and more specifically the Tuscan coast, the Ottoman atlas has been compared with the mediaeval nautical charts and with the early sixteenth-century production (Lepore, Piccardi, Pranzini, 2011). In the quest for sources that may have inspired or influenced the Ottoman Admiral, we have identified and more closely analysed the authors of several nautical charts and atlases and of *isolarii.*

This article focuses on cartometric issues relating to mediaeval nautical cartography (Portolan charts). More specifically, it analyses the 1403 chart of Francesco Beccari conserved in the Beinecke Rare Book and Manuscript Library of Yale University. This chart represents a crucial turning-point in the development of nautical cartography: namely a refinement in the drawing of the coasts relating to the Atlantic, with corrections that were partially retained in subsequent production. It also features a graduated scale of latitude which is considered a later interpolation. The technique behind the construction of the portolan chart (with a rapid incursion into the symbolism connected with the place name colouring) will be analysed in detail, placing it in relation to other selected models that have been conserved. The aim is to make a contribution to the debate on the techniques of construction of the portolan charts.

Francesco Beccari was active between 1399 and 1426 in Genoa, Barcelona and Savona; only one chart by him has survived, produced in Savona and signed in February 1403. Also traceable to Francesco are the three charts copied in the Egerton 73 manuscript in the British Library, while significant similarities with the drawing and partitions of the 1403 chart can be observed in portolan 22 of the Biblioteca Nazionale of Florence, which has been traced to the last quarter of the fourteenth century and attributed to the Cresques atelier.

We do not have much biographical information about the authors of the portolan charts, and the life of Francesco is no exception. From the spring of 1399 he was in Barcelona, engaged with Jafuda Cresques – a Muslim turned Christian who had taken the name of Jaime (or Jaume) Riba (or Ribes), son of Abraham, founder of the namesake workshop – in the drafting of "*quatros mapamondos*". In effect, in the contract drawn up with the Florentine merchant Baldassarre degli Ubriachi, studied by Skelton (1968) the *magister chartarum navigandi* of Genoa was to deal with the decoration and the Catalan with the geographical aspect.

Francesco Beccari is now considered to be one of the best nautical cartographers of the mediaeval period. He was distinguished from other colleagues by his meticulous correction and updating of the different elements of the nautical chart, revealing a particular interest in the Atlantic coasts. His per-

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sonal revision of the nautical representation was, according to what is stated in the Latin colophon on the 1403 chart, developed from the reports of "*patronos, nauclerios et marinarios sufficientes in artes marinarie*" (experienced shipowners, masters and seamen). Francesco's work was continued by Battista (undoubtedly active between 1426 and 1435), probably his son, who worked in Genoa and Majorca. Two charts by him have survived, and another two are attributed to his atelier.

The debate that has accompanied the analysis of the portolan charts from the nineteenth century has – especially in the early days – been characterised by a national pride that exalts the role and features of the principal Mediterranean schools: Genoa, Majorca and Venice. The same phenomenon also accompanies reflections regarding Beccari's influence on subsequent production. For example, the Italian Magnaghi (1909), examining the 1447 map of Volterra by Pietro Roselli, or Pere Rossell, and in particular the colophon "*Petrus Rofelli compofuit hanch cartam de arte baptiftae becarij /Jn ciuitate maioricarum anno dominj .M. cccc xxxxvij",* suggests that Beccari's success led the Majorcans to abandon the model established by Angelino Dulceri/de Dulceto/ de Dalorto. This affirmation was rebutted by Winter (1952 and 1954) and later attenuated by Rey Pastor and Garcia Camarero (1960) who, despite appraising reciprocal influences, discern the persistence of the models in the Italian school in the works of Battista Beccari, Albino da Canepa, Grazioso and Andrea Benincasa and the Freducci.

However what both stances appear to take for granted is that the scale of latitude – plausibly the most innovative element to appear in the 1403 chart – is to be considered a posterior interpolation. The surviving mediaeval charts, produced between the thirteenth century and 1501, and listed by Campbell (1986, 1987, 2009a, 2009b, 2010b) are less than two hundred in number although, as stressed by Campbell himself and by Pujades i Battaler (2007), the surviving charts are but a tiny percentage of what was a vast production. With the two exceptions of Francesco's chart and the anonymous 1548 manuscript in the Huntington Library, none of these has a scale of latitude.

The *terminus ante quem* chosen by Campbell is related to two important innovative elements that emerged in the first decade of the sixteenth century: the expansion of the area traditionally covered by the portolans to the Spanish discoveries, and the appearance first of the scale and later of the degrees of latitude. There is, however, no precise date marking the appearance of this element, since the charts identified are not dated.

In this regard we can consider the planisphere by Juan de La Cosa, dated around 1500, which shows the Equator and the Tropic of Cancer, albeit positioned with a degree of approximation, or the Cantino chart, around 1502, identified the Tropics, the Equator and the Arctic Polar Circle. Instead, for the appearance of the degrees we have to turn to either the chart by Pedro Reinel (although the debate on the 1504 dating is still open), to that of Niccolò Caveri (this too undated and attributed to the years 1504-1505) or to the certainly-dated 1516 chart by Vesconte Maggiolo. The appearance of the scale of latitude is seen as a turning-point in the history of cartography, and of nautical charts in particular, and all the commentators either ignore the 1403 chart or consider the scale as a later juxtaposition.

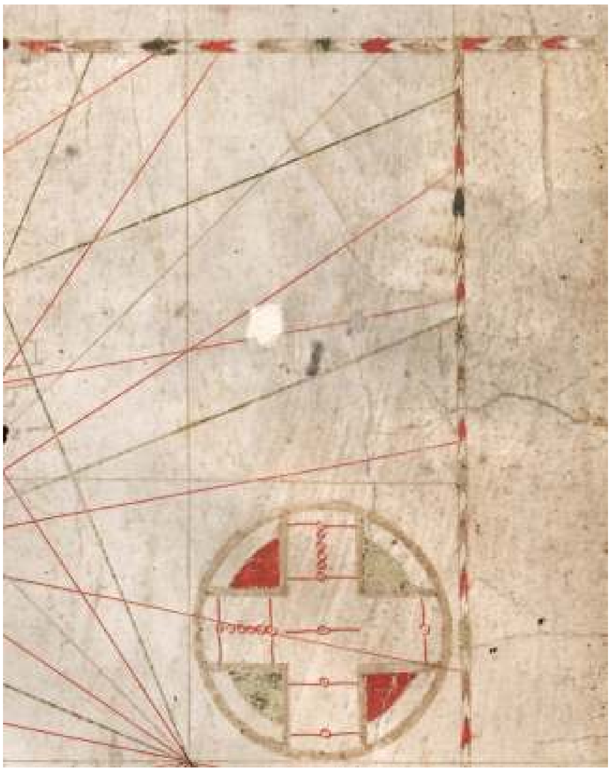

Figure 1: Pietro Visconte (a. 1311), scale of distances and polychrome border

The case of the scale of distances and other elements which complete the nautical chart is another matter. All the portolan charts feature a scale of distances. When subjected to cartometric analysis, and probably partly as a result of undisputed phenomena of imitation, many of the charts both precedent and subsequent to that of Beccari illustrate in the Atlantic profiles a certain adhesion to modern latitude data. In some cases, detectable even in the more ancient exemplars, the portolan charts are sometimes circumscribed by a more or less dense polychrome grid which develops along the border made up of individual segments of the same size. This is the case, for example, in the first signed portolan chart that has survived, that of Pietro Vesconte of 1311, in that produced by Giovanni da Carignano around 1327 (as far as we can deduce from the photographic reproduction which alone has survived) and in the later portolan 16 of the Biblioteca Nazionale of Florence, where the grids are aligned with a cromatic scale positioned in the borders. More frequently, on the western border there is a scale of distances that can be repeated on the same and on the northern and southern borders, where it may be juxtaposed to or inserted into the polychrome border. With rare exceptions, the scale of distances is framed by several parallel lines deriving from the main wind rose and from the secondary centres.

The 1330 chart by Angelino de Dalorto repeats a model analogous to that of the chart by Giovanni da Carignano, which was also proposed by later authors. In the “corridor” of the Gulf of Biscay the scale of distances is framed by two parallel lines that cross the chart. The scale is divided into seven segments that cover the space between Cabo San Mateo (48°19’ lat.) and San Sebastian (43°19’ lat.): an angular distance of 5 degrees.

The position occupied by these scales of distances suggests an archaic element, preliminary to a scale of latitude and probably the result of a calculation of distances that may recall a geographical coordinate.

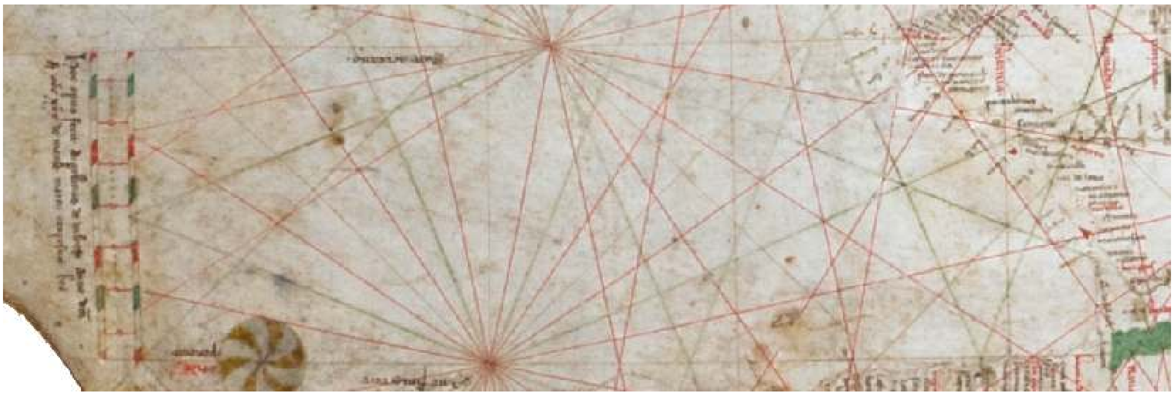

Figure 2: Angelino de Dalorto. The scale of distances related to Golfo di Biscaglia

Continuing to refer to the de Dalorto chart, although the examples are numerous, the north-south parallels too, which originate from four symmetrical roses, correspond to the space occupied by three scale measurements divided into seven segments and arranged in the upper and lower borders of the chart. In Pietro Roselli's chart of 1462 (Paris, BNF, Rès. Ge. 5090) we see, on the lower border, the same system used by Dulceto with the difference that the scale of distances runs on two adjacent quadrants distinguished respectively by 8 and 9 segments. For the sailors, this information did not indicate distances alone but could also suggest an, albeit approximate, calculation of longitude.

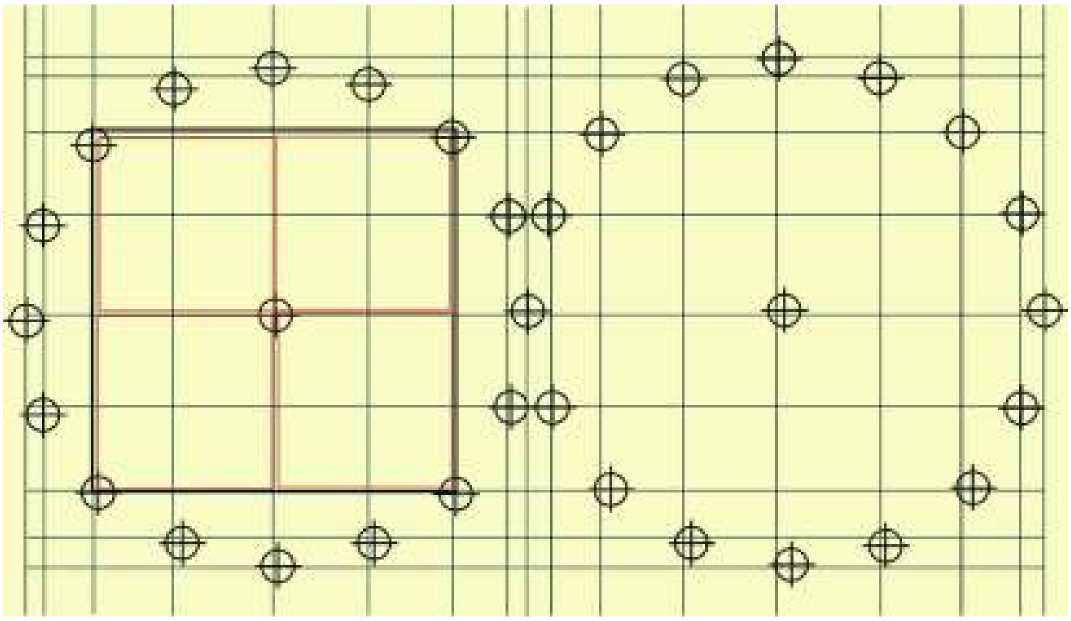

Figure 3: The geometrical pattern of the design of the chart with two circumferences by Angelino de Dalorto a. 1330.

Proceeding with the structural analysis of the mediaeval nautical chart, it is possible to identify those elements that the drawings produced between the thirteenth and the fifteenth centuries share. In addition to the graphic scale of distances (rarely accompanied by very short notes on the scale reduction) there are one or two circumferences regularly divided into sixteen arcs which give rise to the dense network of rhumb lines characteristic of the nautical production. Then the profile of the coast emerges, accompanied by toponyms carefully placed so as not to conceal the drawing, the main rose and any embellishments that enhance the general visual content. These features having been accepted, the debate then arises among the commentators regarding the passages and the hierarchy of execution that makes it possible to create such extraordinarily realistic charts. The need to respond to the perplexities that arise in relation to the appraisal of the graduated scale of latitude of Francesco Beccari's chart lead us to analyse an exceptional cartographic model, although some of the observations made for Francesco also reveal affinities with previous charts.

Before proceeding, we have to take into consideration the real possibility that the phases recognisable in the finished product do not actually correspond to the phases of construction. In substance, certain elements of the chart may not have been defined in ink, producing a misleading effect in the analysis of the layering of the inks. We should say straight away that in Francesco Beccari's chart the rhumb line network does not appear to be what other commentators consider a primary element in the construction of the chart. Toponyms and the design of the contours are in close relation of reciprocal available space, and, as we shall see below, the possibility cannot be ruled out that the toponyms, and those in red in particular (or a mere dot used to indicate their position), were inserted in an earlier phase. The positioning of the scale of distances is in relation to the orthogonal rhumb line network, and its function in relation to the drawing of the coastal contours is also related to the orientation and definition of a grid that divides the space in a preparatory manner (as in numerous examples replicated in terrestrial cartography) facilitating both the drawing and the proportions of the coastline and the placement of the remaining points.

In the bibliographical investigations carried out in the preparation of this paper, Beccari's graduated scale of latitude is frequently taken as a posterior juxtaposition, albeit without any further clarifications of this assumption being provided. And here once again we have to the turn to Campbell who refers us back to a study by Almagià (1952).

Figure 4: Francesco Beccari (a. 1403). Scale of latitude, Isola di Brazil, Laymerich (Limerick, Ireland, in red.

Examining the chart drawn upon two parchments joined together (total measurements 93 x 139 cm, making it the largest mediaeval chart to have survived), the Italian scholar writes that “Una graduazione delle latitudini da 27° a 52° e due scale di miglia spagnole e olandesi [?] sono forse da ritenersi aggiunte inserite più tardi”. (A graduation of the latitudes from 27° to 52° and two scales of Spanish and Dutch miles [?] are **possibly** to be considered as later insertions). However, the chart must have been in such a condition that it was hard to read at the time, since the degrees shown actually run from 26° to 55° and, as we shall see below, can be expanded up to 58°. On a first reading of the high resolution digital image of the Beinecke Rare Book and Manuscript Library of Yale University, the inks (both the red of the partition of the scale itself and that of the adjacent, mythical spherical island of Brazil, and the “black” of the numbering of the degrees of latitude also used for the adjacent toponyms) do not appear to reveal differences. An overall view gives the impression of the chromatic homogeneity of the chart, and the red of the rhumb lines when superimposed with the colouring of the scale of latitude and the scale of distances at top left, does not appear to be chromatically different. A close reading of the graduated partitions of the scale enables us to observe that the lines radiating from the wind rose appear to overlay the colouring of the scale. An exchange of e-mail correspondence with the Beinecke library which conserves the original has enabled us to rule out specific studies (for example analysis of the inks) sustaining the theory of juxtaposition. In effect, there is another example of a pre-sixteenth-century portolan chart with a graduated scale of latitude. Conserved in the Huntington Library (Ms HM 1548) is a chart assigned to the last quarter of the fifteenth century which shows an outline of latitude scale (from the end of the 23° to the 54° degree) not coloured, by a hand and in an ink different from the rest of the illustration, covering the drawing and toponyms of several Atlantic islands. However, while the subsequent superimposition of the Huntington chart appears indisputable even at first glance, the effect of Beccari's chart is the opposite. The arrangement of the toponyms between 27° and 29° appears to be determined by respect for a scale that from here runs northwards until it grazes the westernmost extremities of Europe (Ardorm/ Capo Dunmore and the Isole Blasket).

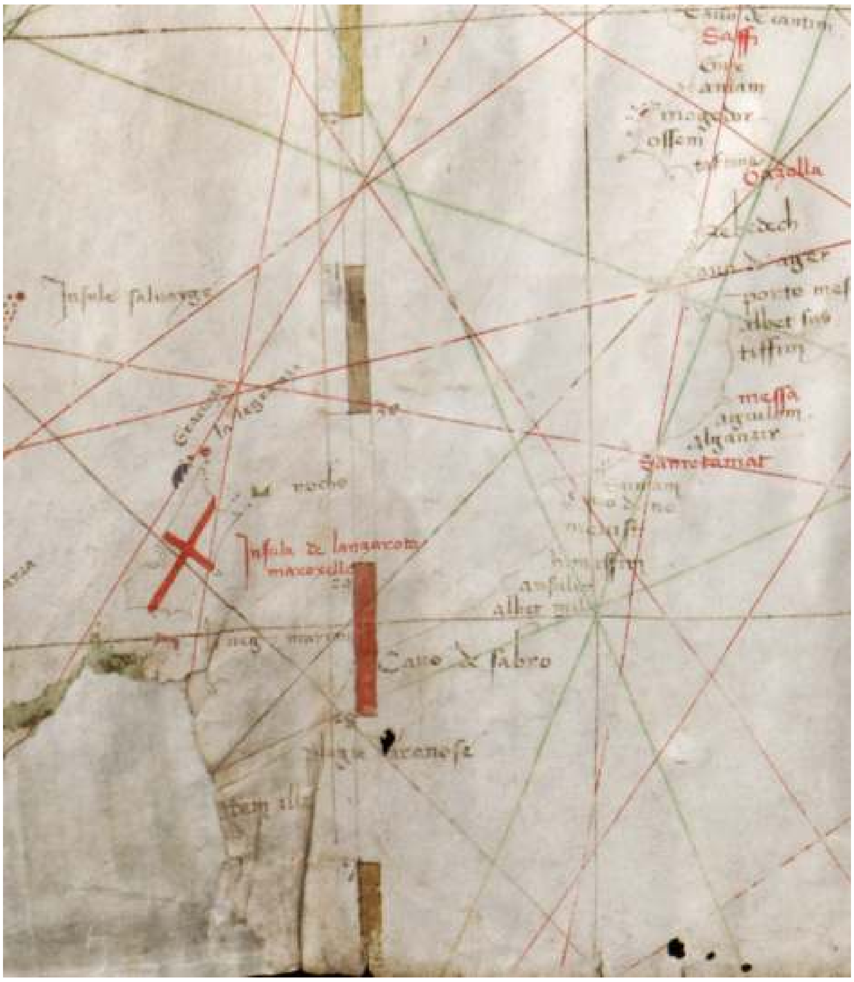

Figure 5: Francesco Beccari (a. 1403). The scale of latitude "respected" by the toponyms

Our attention was also captured by the horizontal and vertical lines originating from the wind rose. Where they intercept the contour of the coastline they correspond to toponyms indicated in red, or end between two place names indicated in the same colour. This leads us to believe, contrary to what has been stressed by other commentators, that this colouring is not reserved only for the more important places (also because many of the latter are not shown in red, while smaller settlements, promontories and bays are) but rather indicates the availability of data considered certain, at least as regards latitude, possibly accompanied by sufficiently precise linear distances which could be related to discontinuous, non-homogenous longitude data invalidated by the magnetic declination. This statement is supported both by the consideration that Francesco Beccari and other chartmakers had, as we shall see further on, a perception of the extension of the Mediterranean that was very close to the real, and by the correct positions of latitude of the Atlantic locations in red as shown in the table.

Moreover, the concept of the earth being round having been accepted, in the boreal hemisphere the calculation of latitude based on the observation of the pole star (or other star) and on the measurement of the height at the horizon was a relatively simple operation. Beccari's chart precedes by just a few years the Latin translation of Ptolemy's work, which not only reveals errors in the coordinates of positions, but overestimates by 20 degrees the measurement of the Mediterranean in longitude. In the Muslim world, instead, Ptolemy was known and studied through a ninth-century translation, and it appears certain that his coordinates had been revised: despite the circulation of Ptolemy's thought in Europe prior to the 1406 translation by Jacopo d'Angelo of Scarperia (Gautier Dalchè, 2009), it comes naturally to rule out that Ptolemy's original calculations could have been at the basis of the corrections made to the Atlantic coast by Beccari.

Turning now to an analysis of the procedures employed in the making of the chart, it appears probable that the scale of latitude was drawn after Beccari had identified the western (Tenerife, L'insula de l'Inferno) and eastern (Batuni ?, Vati in a Black Sea surprising close to reality) limits of his representation, calculating the distance as if these were arranged on the same axis (figure 6, phase 1).

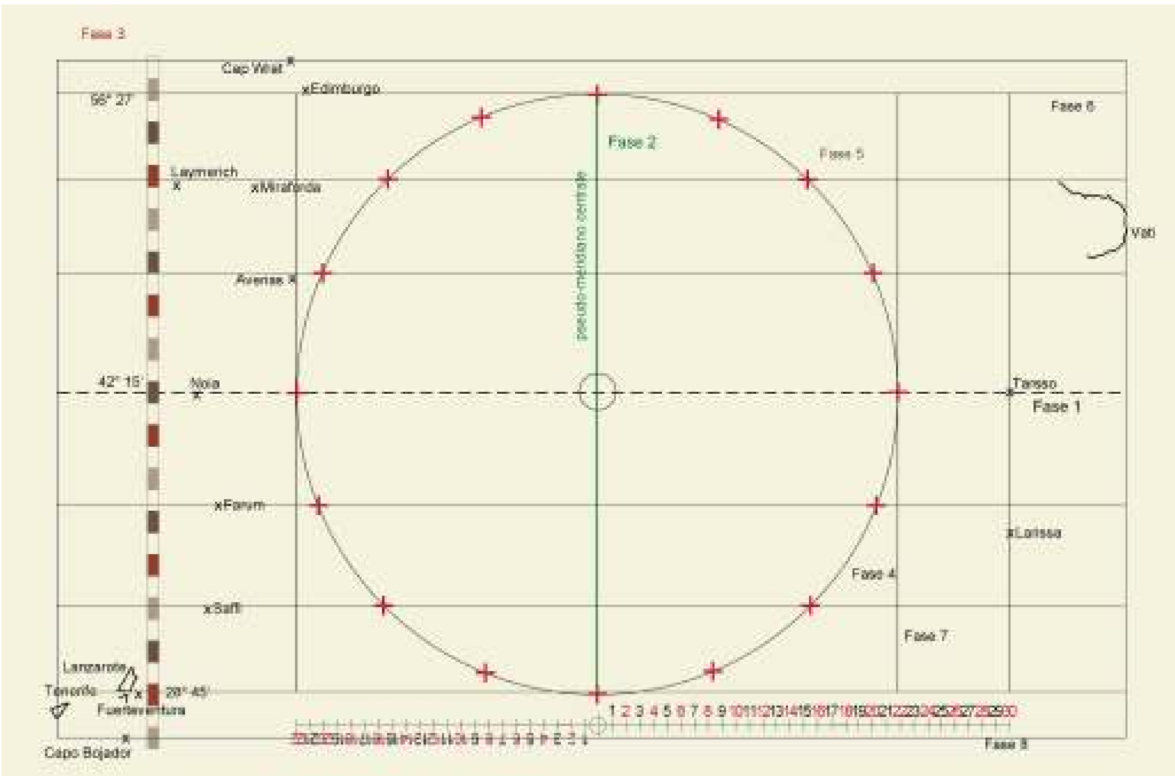

Figure 6: Phases in the construction of Francesco Beccari's chart of 1403

Having identified the mid-point of this distance, he draws a vertical line: the first axis of the main windrose (2). At this point the scale of latitude comes into play (3) which serves Beccari for identifying the centre of the main wind rose on the first vertical partition. He takes as reference the latitudes of the Atlantic extremities of Rochbruch (Edinburgh, c. 56°27” lat.) positioned at 57° and 1/3 (see table) and of the channel between Lanzarote and Fuerteventura 28 and 2/3 (c. 28°48” lat.). Once again, he divides this distance in two and positions the centre of the rose at a latitude of 42° and 1/4: this coordinate intercepts the toponym Noia in red. The next step is the construction of a circumference (4) the radius of which is calculated on the distance from the centre of the extreme points indicated above. This means that the northernmost part of England as far as Cap Wrat, that can be estimated as 58° and 1/3 and, to the South, the lowest point of the African coast, with Cape Bojador hidden by the laceration at the lower edge of the sheet on the 26° degree, are excluded from the circumference, being relegated to a secondary partition. After this the circumference is divided into 16 parts (5).

Starting from the northern and southern extremities of the circumference and from the sixteenths aligned on the two hemispheres, he draws six lines (6) that cross the scale of latitude: this forms a partition of as many parallel lines with distances that decrease identically on either side of the central pseudo meridian corresponding to around 5°20”, 4°40” and 4° (leaving the northern and southern borders to the aforementioned secondary partitions).

The points at which these median lines cross the circumference then give rise to the secondary centres, but the most interesting aspect is that these lines intersect toponyms marked in red: Laymerich in Ireland and Miraforda in Wales, Avenas in Brittany (here the fact that the red ink is superimposed on the median line makes it clear that the toponyms were added in a phase following that of the drawing of the radiant lines), the aforementioned Noia, Farum (Faro, in southern Portugal), Saffi (modern Safi) and the channel between the islands of Lanzaroto Maroxello and Fuerteventura as mentioned above .

This was not a new method of construction, and there are marked analogies with the portolan 22 of the Biblioteca Nazionale of Florence referred to above and with the technique of Guillelm Soler.

The precision of the latitude data decreases progressively from the Atlantic coasts towards the Mediterranean, and there are no references at all on the chart to degrees of longitude. The pseudo-meridian and the east-west boundaries of the circumference (7) delimit the positioning of the scale of distances on the lower border (8). Starting from the pseudo-meridian, this extends for 22 segments both westwards and eastwards. On Google Earth we traced and measured the limits of the scale, taking as reference the alignments on the African coast: we are dealing with approximately 1,400 kilometres as far as Tarso Quarato (Tarzus, Morocco) and approximately 1,430 km as far as Porto de Raza (very probably Mersa Matruh in Egypt). This suggests that the chartmaker must have either been in possession of longitudinal data or of a reliable calculation of the distances between the points on the African coast. Otherwise it is impossible to explain the practically perfect correspondence between the real distances between Tarso Quarato-Casa Rullo-Lagu Segio (Samma-Zuwarah-Matruh) and those shown on the chart.

We can observe that approximately 28° separate the northern tip of Ireland from Gran Canaria. Having checked the correct correspondence between the approximately 110 km (the average length of a degree of latitude) and the distances on Beccari’s chart, we rotated the scale of latitude to transpose it to the Mediterranean axis running from Gibraltar to Jaffa (little more than 3,700 km): this distance is covered by a measurement equivalent to the 35 degrees chosen by Beccari which would lead to 3,850 km. the scale of distances in this and other segments that appear on the lower and upper borders of the chart thus become, in our opinion, the point of reference for the longitudinal positioning of the Mediterranean locations.

Finally, to cover the entire Mediterranean, Beccari is obliged to prolong the scale of distances eastwards. For this he uses a secondary partition that crosses the Anatolic toponym of *Tarsso* (in red) and *Larissa* (Arish in Sinai) corresponding to 9 segments (5 indicated) and approximately 585 km. The secondary western partition, placed at a very short distance from Capo Finisterre will be covered by the same distance of 9 segments (not indicated). In effect, the Mediterranean axis is not entirely covered by the scale of distances, since the outermost borders are left out (the Alboran basin and the stretch of about 100 km between Cyprus and the continental profile of Asia); nevertheless, anyone consulting this chart would have been able to calculate the distances using the simplest of rules (as we did).

Finally, in table 3 we compared the latitude coordinates of seven places on the Atlantic coast as observed on the chart by Francesco Beccari, on the anonymous Huntington chart and in four sixteenth-century charts. The method employed is extremely simple: we used one of the most common types of software to process the digital images and we marked out rulers to align the toponyms examined with the graduated scale. In the case of Francesco, leaving aside the debate about the contemporary nature of the drawing and the scale, the autonomous succession of the toponyms on the Atlantic coast offers surprising coincidences when set in relation to the *Google Earth* coordinates. At the same time, the comparison demonstrates that almost all the latitude data recorded in 1403 are closer to reality than those recorded in the sixteenth century. Among the chartmakers is Pedro Reinel (who signed one of the earliest surviving Portuguese charts) who, together with his son Jeorge, was considered one of the leading Portuguese cartographers of the first half of the sixteenth century. Finally, considering all the coordinates shown in the table, we can see how the values become imprecise in the more northerly locations, while the anonymous Huntington chart continues to offer generally acceptable values, that do not however have correspondences with the later charts examined.

However, this is not to say that Francesco's chart is not without errors. In the Tyrrhenian Sea, Sardinia appears to be well-placed in relation to Ventimiglia (7°33') and Ancolla (Collo, 6°34' recorded on the Algerian coast) but its positioning in relation to the Italian peninsula is imprecise, since the southern tip of Sardinia is aligned not with S. Eufemia but with the northern coast of Sicily. Again we can observe that the data for the western Mediterranean prove to be more accurate than the eastern portion, while we can also note the characteristic shared by the other portolan charts of a Magreb coastline that takes a decidedly north-eastern direction. The precision that distinguishes the latitude of the Atlantic locations is progressively lost in the routes towards the eastern Mediterranean. Thus we find Noia aligned with Adana, while in reality the former is located on the 43° N and the latter on the 37° N. On the other hand, while in the Mediterranean the experience of coastlines, islands and routes gathered over the centuries had become a sort of common, practical knowledge, the case of the Atlantic was different: this was still seen as an infinite and unknown ocean in which the landmarks and distances called for much more precise positioning and measurement.

The above considerations not only appear to establish a link between Beccari's chart and the geographical drawing of the early sixteenth-century charts, which has been seen to be based on a plane projection (that does not consider the convergence of the meridians and practically equalises the degrees of latitude and longitude) (Crone, 1953), but also make deflate the significance of the considerations regarding the contemporary nature of the drawing and the scale.

		Coordinates (Google Earth)	Beccari a.1403	Anonymous Huntington (fine XV sec)	Reinel a.1504 ca	Vesconte Maggiolo a.1516	Diogo Homem a.1563	Rizo Oliva a.1575
1	Limerick (Ireland)	*52° 40"*	51 and 2/3	51	54	54 and 1/3	53 e 1/3	54
2	Cap de la Hague (France)	*49° 43'*	**50**	**49** and **1/5**	51	51 and 1/3	50 e 2/3	50 and 2/3
3	Glenan island (France)	*47° 43'*	**47** and **2/3**	46 and 3/4	48 and 2/3	49	**48**	**48** and **1/3**
4	Noia (Spain)	*42° 44'*	**42 1/4**	**42** and **1/3**	**42** and **2/3**	43 and 2/3	**43**	43 and 2/3
5	Adra (Spain)	*36° 42'*	**37**	**36** and **1/3**	**37** and **1/3**	**36** and **2/3**	**37**	**37**
6	Capo delle Forche (Morocco)	*35° 26'*	**35** and **2/3**	**35** and **1/3**	**36**	**35**	**35** and **2/3**	**35** and **2/3**
7	Gran Canaria	*27° 57'*	**27** and **2/3**	**27** and **1/3**	**27** and **2/3**	**27** and **1/2**	**27** and **1/3**	26

Table 1. Latitude data from XV and XVI century portolan charts. The fractional values of latitude are the result of the division into three portions of the segment of the degree shown in the various charts. This subdivision leads to an approximation of + - 10" (circa 17 km). The approximations that are reduced to less than half a degree are indicated in bold.

The data on the locations on the Atlantic coast are correct in terms of latitude and the extension of the Mediterranean in linear distance is very close to the real; consequently either the date of 1403 is false or, in terms of the Atlantic coastline, the chart is constructed on criteria of latitude accompanied, in some portions, by almost reliable distances in longitude.

It is therefore inevitable to note that, in the charts of Battista and those of the fifteenth-century cartographers, the absence of the graduated scale of latitude either calls for a downsizing of the influence exerted on subsequent cartographic production or, on the contrary, represents an overvaluation on our part of an element that was in effect already present, albeit not shown, in previous production too. Bearing in mind the reluctance of captains, even in the sixteenth century, to use charts constructed on the basis of the new astronomical criteria (Sandman, 2004) we could also assume that the non-replication may have been a consequence of the disinterest or even hostility of the intended users. Nevertheless, it has to be noted that, right up to the end and the turn of the sixteenth century portolan charts continued to be produced without any scale of latitude (such as those drafted by Reinaut B. de Ferrieros and Matteo Prunes in 1592 and by Placido Oliva in 1621). In this sense, Beccari's chart would appear to be early evidence of a map that brought together a traditional drawing technique (in the Mediterranean) with the astronomical method of the new cartography that was to become consolidated in the following century.

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