CHAPTER 1

Early Modern Nautical Cartography of the Adriatic Sea: An Overview

Josip Faričić and Tome Marelić

1 Nautical Cartography of the Adriatic Sea in the Early Modern Period

Due to its geographic position and importance within the Mediterranean socioeconomic framework, the Adriatic Sea and its adjacent regions have historically been a locus of interactions and conflicts, as well as a hub for continuous cross-cultural exchanges of goods, ideas, and technologies, rendering it the "the Mediterranean on a smaller scale" (Braudel 1972; Ivetic 2019). In the early modern period, numerous political entities that significantly influenced Europe's political, economic, and cultural landscape also impacted the historic development of the Adriatic Sea (Figs. 1.1 and 1.2). The Republic of Venice, established in the Middle Ages and dissolved by Napoleon in 1797, was one of the most influential entities, consistently endeavouring to assert itself as the dominant power while adeptly navigating various political fluctuations. Alongside its considerable territorial expansion along the northern and eastern Adriatic coast, Venice has

J. Faričić (✉) • T. Marelić
Department of Geography, University of Zadar, Zadar, Croatia
e-mail: jfaricic@unizd.hr; tmarelic@unizd.hr

J. Faričić, T. Marelić (eds.), *Early Modern Nautical Charts of the Adriatic Sea*, https://doi.org/10.1007/978-981-96-8046-7_1

Fig. 1.1 Political map of South and Southeast Europe for the year 1600. Basemap shapefile source: marineregions.org (Claus et al. 2017)

governed Corfu since 1204, located at the junction of the Adriatic and Ionian Seas. Venetian official cosmographer Vincenzo Maria Coronelli stated in his isolario *Citta, Fortezze, ed altri Luoghi principali dell' Albania, Epiro e Livadia, E particolarmente i posseduti da Veneti* (published in Venice in the 1690s) that Corfu is "Porta di questo Mare, Antemurale d' Italia and Propognacolo della Cristianità …" ("Gateway to this Sea, Bulwark of Italy and Bastion of Christianity …"). At the time, certain coastal areas of the Adriatic were under the Habsburg Monarchy (a portion of Istria, the Kvarner coast, and the Velebit region) and the Ottoman Empire (a part of Dalmatia, the territory of present-day Montenegro, and present-day Albania), whereas some smaller parts of southern Dalmatia belonged to the Republic of Ragusa (Dubrovnik). On its western coast, the territories belonged to the Papal States and the Kingdom of Naples, later known as the Kingdom of the Two Sicilies (Chaline et al. 2001; Ivetic 2019).

Fig. 1.2 Political map of South and Southeast Europe for the year 1750. Basemap shapefile source: marineregions.org (Claus et al. 2017)

Throughout history, seafaring has been a crucial catalyst for economic and cultural activities and developmental interactions in the Mediterranean (Abulafia 2011), encompassing a complex array of elements such as navigation, shipbuilding, maritime affairs, port management, trade, fisheries, and even warfare. Consequently, seafaring relies on the integration of knowledge and technologies from diverse scientific and professional domains, with nautical cartography holding a particularly significant position. Contemporary nautical charts, predominantly in digital format and integral to electronic navigation systems, are the culmination of a long-standing tradition of maritime connections with various scientific fields, evolving alongside technological advancements. As a result, they constitute an essential part of maritime culture, contributing as a vital aspect of both the tangible and intangible cultural heritage of the Mediterranean regions.

Since the beginning of seafaring, sailors relied on accurate information regarding the geographic characteristics of the maritime regions they traversed to establish safe and precise courses, as maritime navigation is inherently less predictable and more perilous than terrestrial travel. A more accurate understanding of the spatial composition of surrounding geographical features, bearings, and distances between them, along with the subsequent use of spherical coordinates to define their locations, could partially mitigate the unpredictability of sailing and help create nautical charts of adequate planimetric accuracy. This means that the history of cartography is basically linked to the history of the sciences, particularly mathematics, astronomy, geography, and geodesy, which is easily seen by observing the history of nautical cartography (Turnbull 1996).

The earliest known navigational aids are *periploi*, written accounts of sailing routes along coastlines, with distances usually conveyed in days of sailing, created during antiquity, with some of the oldest known examples being the *Periplous of Pseudo-Scylax* (fourth century BCE) and *Stadiasmus Maris Magni* (c. third century) (Taylor 1957; Shipley 2011). During classical antiquity, monumental astronomical, geodetic, and cartographic achievements were undertaken, resulting in assessments of the Earth's size, determining its surface within spherical geometry by assigning latitudes and longitudes to locations, and developing map projections to flatten it into a plane with defined mathematical parameters (Keuning 1955; Dilke 1985; Snyder 1993). However, there is no positive historical evidence that these scientific advancements were employed to create nautical charts during classical and late antiquity.

As far as is known, the roots of nautical cartography date to the late thirteenth and early fourteenth centuries, marked by the sudden historical emergence of *portolan charts* in the Mediterranean (Fig. 1.3). These manuscript charts, drawn with ink on sheets of vellum and primarily focused on the coastline areas, are recognisable for their distinct visual characteristics, which clearly distinguish them from any other known type of earlier-made map. Portolan charts were named after their content-wise similarities to *portolans* (*portolani*), late medieval and early modern texts that contained useful navigational data such as bearings and distances between the significant ports, capes, or river mouths (Campbell 1987; Monmonier 2004; Pujades i Battaler 2007), although certain scholars prefer to label them only as *nautical charts* (Gautier Dalché 1995, 2002). Their most outstanding feature, the exceptionally realistic portrayal of coastlines, is intriguing due to a complete lack of their development path, since the

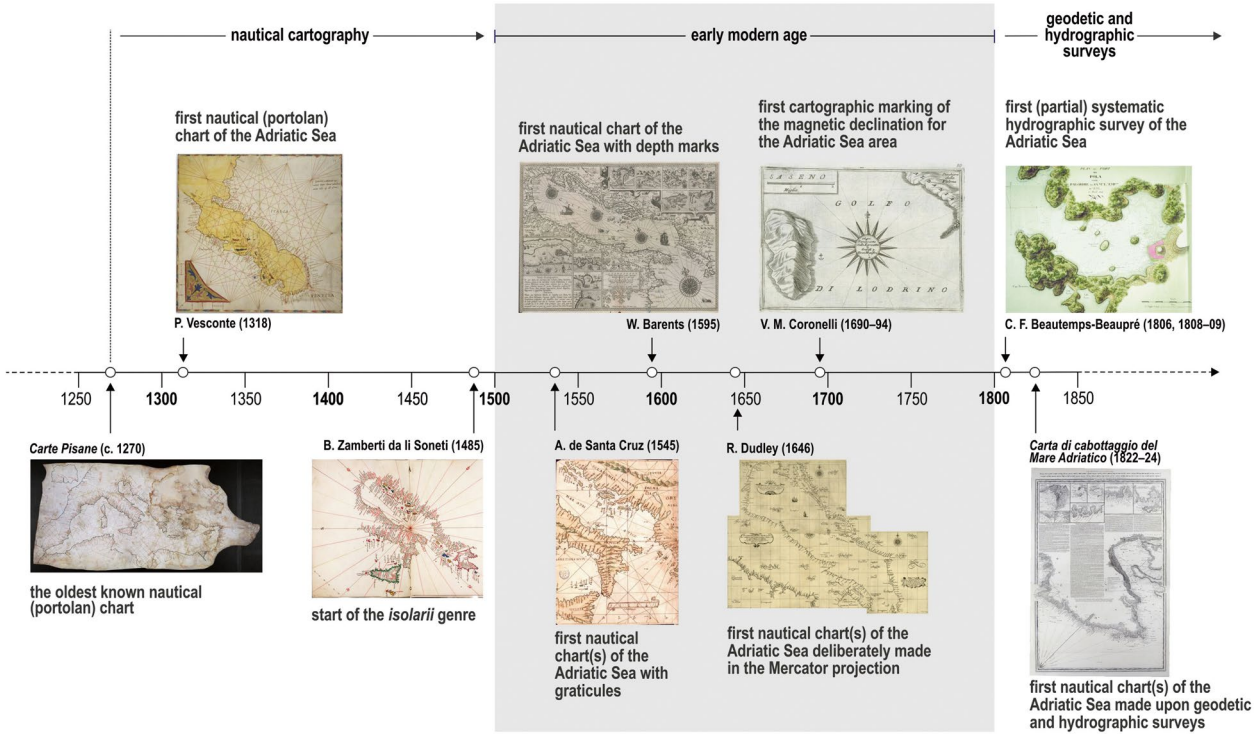

Fig. 1.3 Milestones in the history of nautical cartography for the Adriatic Sea area

earliest known charts, such as the *Carte Pisane*, and the *Cortona chart*, already achieved high levels of planimetric accuracy, strongly resembling a modern map in the Mercator projection. Simultaneously, they also raise questions about their origin because the cartographers who drew them left us no clear information on how the spatial data underlying their geometry was initially observed and assembled into a coherent framework (Nicolai 2014, 2024; Marelić 2024b, 2024c, 2025a). Apart from their geometry, there are other prominent features specific to portolan charts. The most recognisable are wind roses, occasionally referred to as rhumb lines. These are dense networks of straight, colour-coded lines that radiate from one or more centres in 32 directions, named after eight cardinal winds and their cross-combinations. In the later stages of portolan chart production, wind roses were typically supplemented with artistic representations of compass roses, which were occasionally very ornate. Although early modern cartography saw the introduction and gradual implementation of graticules of latitudes and longitudes, the nautical cartography retained wind roses and compass roses until the mid-nineteenth century (Wagner 1896/1969; Astengo 2007; Faričić et al. 2023a). Other notable features include the use of linear scale bars and the inscription of toponyms perpendicular to coastline contours, which were progressively abandoned during the early modern period and became inscribed horizontally. As far as is known, linear scale bars appeared on portolan charts for the first time in history and are still frequently employed, not just in nautical cartography but in general.

Previous research on medieval and early modern nautical charts of the Mediterranean Sea has revealed that only a small number of them were actually used for navigation, as the preserved examples contain no traces of sea salt, punctures made by the usage of compasses (navigational dividers), or other signs of wear typical for the navigational application. Instead, most surviving charts seem to have been made for land-based users interested in the geographical features of the sea and coast for economic, political, or academic purposes (Campbell 1987; Sheehan 2012). Their production placed a great emphasis on aesthetics, leading Corradino Astengo (2007) to classify them as *decorative charts*. These charts are, in many instances, preserved and stored in archives and libraries, unlike those used in navigation, which are now presumed lost, seemingly due to their deterioration caused by shipborne use (Campbell 1987; Astengo 2007). Notably, numerous historical documents confirm that nautical charts were used for navigation, including records indicating that they were a

mandatory part of ship equipment (Pujades i Battaler 2007), and one of the most important such historical testimonies is the *De Navigatione Liber* treatise, written in 1464 by Benedetto Cotrugli of Ragusan origin, in which he thoroughly describes how nautical charts are to be used in navigation (Cotrugli 1464). Although the exactitude and verisimilitude of charted areas and the navigational utilisation have always been the most important aspects of nautical cartography, they were often intertwined with elements that are non-navigational in essence, especially during the early modern period. Apart from technological advancements and scientific accomplishments of the time, early modern nautical charts also mirrored the illustrative abilities, expressive styles, geographical expertise, or ideological and political perspectives of their authors. For centuries, cartographers have balanced both scientific precision and artistic expression (Ribeiro and Caquard 2018), a duality that is evident in the interplay between art and science within cartography that encompassed both linear and "painterly" techniques (Karssen 1980; Krygier 1995; Cartwright 2009), and some historians of cartography assert that a map "can be observed like other artistic phenomena: creation of objects, medium of composition, circulation of motifs, and their evolution" (Vagnon 2007: 293). However, the question arises as to how a nautical chart could have concretely served sailors and other interested users in this context. To nautical chart users, cartographical representations suggested different messages and presented various perspectives on the depicted maritime, island, and coastal spaces. In general, maps are more interpretations of facts than objective representations of facts that are devoid of any given meaning. Maps contain ideological and rhetorical devices that are intertwined with depictions of geographical objects in physical space. Therefore, different types of maps "can document a social history of power, especially power over space" (Wintle 1999: 137). In a similar manner, Emanuelle Vagnon highlights that: "Mapping the seas is a way of knowing, discovering, and conquering maritime space" (Vagnon 2021: 170).

Some of the greatest scientific and technological challenges in human history—such as methods on how to effectively plot the rhumb lines (loxodromes) as straight lines on a map accomplished by the Mercator projection in the late sixteenth century, the observations and mappings of the magnetic declination on a global scale since the eighteenth century, and the possibility to accurately observe the longitudes on the open sea accomplished by the invention and the use of the chronometer during the eighteenth century—were often either triggered or promptly adopted by

mariners and nautical cartography (Taylor 1957; May 1973; Hewson 1983). The full integration of science and cartography was achieved in the era of the first geodetic surveys (Turnbull 1996). Since the mid-eighteenth century, the procedure of acquiring and processing spatial data and visualising them on maps became institutionalised and based on the precisely established geodetic surveying methods in order to produce the official topographic maps. Soon after, the hydrographic surveys were employed, whose spatial data was used to produce modern and highly accurate nautical charts (Fig. 1.3). The application and development of contemporary technologies, such as radio and satellite positioning, high-resolution seabed surveying through echo sounding, and computer technology adoption, led to further advancements in the field during the second half of the twentieth and twenty-first centuries. As a result, nautical charts are now a highly accurate and strictly standardised branch of cartography that utilises all the advantages of the geographic information system (GIS) environment.

1.1 The Advent of Nautical Cartography and Mathematical Approaches to Chart-Making

The Adriatic Sea appeared on nautical charts showing the entire Mediterranean, only the central or eastern Mediterranean, as well as the standalone geographical area covering the majority of the map field. In *isolarios* (or *isolarii*) and nautical atlases, some of their smaller segments, especially the ports and harbours, were mapped to a larger scale and shown in more detail. Apart from the anonymous *Carte Pisane*, presumably created in the late thirteenth century (c. 1270), on which the Adriatic Sea is shown together with the rest of the Mediterranean, the first nautical (portolan) chart on which the depiction of the Adriatic Sea covers the entire field was created by Pietro Vesconte in Venice in 1318 (Figs. 1.3 and 1.4).

Vesconte's creation was followed by numerous other Venetian cartographers, for example, Francesco de Cesanis (1421), Giacomo Giroldi (1426), Grazioso Benincasa (1472), and Bartolommeo Zamberti da li Sonetti (1485). Their charts were produced either as individual cartographic works or as parts of comprehensive publications. Bartolomeo Zamberti da li Sonetti, for example, published his nautical chart of the Adriatic Sea (Figs. 1.3 and 1.5) in *Isolario*, one of the prototypes of this genre—a kind of compendium of maps and descriptions of individual islands and harbours that was published from the fifteenth to the seventeenth century (Tolias 2007; Stouraiti 2013).

Fig. 1.4 Pietro Vesconte, nautical chart of the Adriatic Sea, Venice, 1318—the first manuscript nautical chart of the Adriatic Sea (Source: Austrian National Library, Vienna, Call Number: Cod. 594 (Cimel. 20), 10v-11r)

During the sixteenth century, the established medieval practice of producing manuscript nautical charts of the Adriatic Sea continued. In the mid-sixteenth century, woodcut printing began to be used (the first such nautical charts were printed by Pietro Coppo in 1525 and by Giovanni Andrea Vavassore in 1539), followed by the implementation of the copperplate printing technique. Although printed nautical charts of the Adriatic were produced from the first half of the fifteenth century, manuscript charts continued to be made in parallel until the end of the early modern period. Because printed charts were more widely available due to the possibility to produce numerous identical (paper) copies at drastically lower production costs, they held greater communicative potential.

Fig. 1.5 Bartolomeo Zamberti da li Soneti, nautical chart of the Adriatic Sea, Venice, 1485—an example of a chart that is part of comprehensive publications (Source: National Maritime Museum, Greenwich, London; P/21(2); MS 38-9920C)

In parallel, the Adriatic Sea was also depicted on geographical maps, many of which were strongly influenced by its appearance on Claudius Ptolemy's *Fifth Map of Europe*. Although Ptolemy's *Geography*, originally written in the second century CE, was unknown to Western European cartographers until the early Renaissance, when the book was translated from Greek into Latin and subsequently printed in various editions (Kozličić 1995; Berggren and Jones 2000; Gautier Dalché 2007), it exerted significant influence on early modern cartographic representations. Between 1539 and 1560, Alonso de Santa Cruz made *Islario general de todas las islas del mundo*, which contains three charts of the Adriatic (Fig. 1.6), accompanied by their geographical descriptions, many of which were derived from classical antiquity sources (Faričić and Lončar 2024). Unlike other Renaissance authors of comparable works, including Gratiosus Benincasa, Francesco Berlinghieri, and Benedetto Bordone, his charts feature the earliest known representation of latitudes and

Fig. 1.6 The nautical chart of the northern part of the Central Mediterranean from Alonso de Santa Cruz's *Islario general de todas las islas del mundo* (1539–1560) containing the markings of latitudes and longitudes (Source: National Library of Spain (Biblioteca Nacional de España), Madrid, MSS.MICRO/12638)

longitudes on nautical charts for that region (see Fig. 1.3), with longitudes seemingly approximated based on Ptolemy's geographical information.

1.2 Stagnation and Uncritical Reproduction of Obsolete Imagery

During the sixteenth and much of the seventeenth centuries, nautical charts generally offered more accurate depictions of the Adriatic coastline and included a greater number of geographical names for harbours, bays, capes, and islands in comparison with geographical maps. After this period, however, geographical maps began to surpass nautical charts in terms of the quality of their geographical content. During the seventeenth and eighteenth centuries, printed nautical charts of the Adriatic tended to circularly reproduce geographic contents that were already obsolete, mainly

due to uncritical compilation of elements that were derived from previous works. Some notable examples are nautical charts published in series by several Italian, Dutch, and English cartographers in the seventeenth century, which were, in fact, almost identical copies of the nautical chart published by the Dutch cartographer and publisher Willem Janszoon Blaeu in Amsterdam in 1621. Interestingly, this highly influential chart by Blaeu was actually a somewhat more generalised and slightly modified version of a nautical chart of the Adriatic Sea made and published in 1595 by Dutch cartographer and explorer Willem Barentsz in Amsterdam (Fig. 1.7). His chart is also the first one that contains sporadic depth-marks of the Adriatic area that are inscribed within the large-scale insets placed in its upper right and bottom left corners (see Fig. 1.3). In 1646, the English cartographer Robert Dudley finished his *Dell'arcano del mare* book in Naples, the first nautical publication accompanied by charts that were deliberately made in

Fig. 1.7 Willem Barentsz, nautical chart of the Adriatic Sea, Amsterdam, 1595—prototype of printed nautical charts of the Adriatic Sea (Source: Stanford University Libraries, The Barry Lawrence Ruderman Map Collection, Stanford)

the Mercator projection, three of which partially depict the Adriatic Sea (see Fig. 1.3). Although his maps included graticules of latitudes and longitudes, Dudley merely overlaid them on Blaeu's image of the Adriatic (Marelić 2023a).

A somewhat different perspective on the maritime and geographical features of the Adriatic Sea was offered by Ottoman cartographers. Among the most significant of these is the sailor and cartographer Muhiddin Pîrî Reis, who published the *Kitâb-ı Bahriye*—a navigational guide containing numerous maps depicting both the Adriatic Sea as a whole (Fig. 1.8) and specific segments of its coast—several times during the first half of the sixteenth century. Pîrî Reis's original contribution is particularly evident in his detailed depictions of Croatian islands and various Adriatic ports, which were notably superior to the cartographic representations appearing in the isolarios made by Venetian and other European authors in the sixteenth and seventeenth centuries (Kozličić et al. 2015; Mlinarić and Faričić 2024).

The largest portion of nautical charts and geographical maps of the Adriatic Sea were made by Venetian cartographers, whereas the

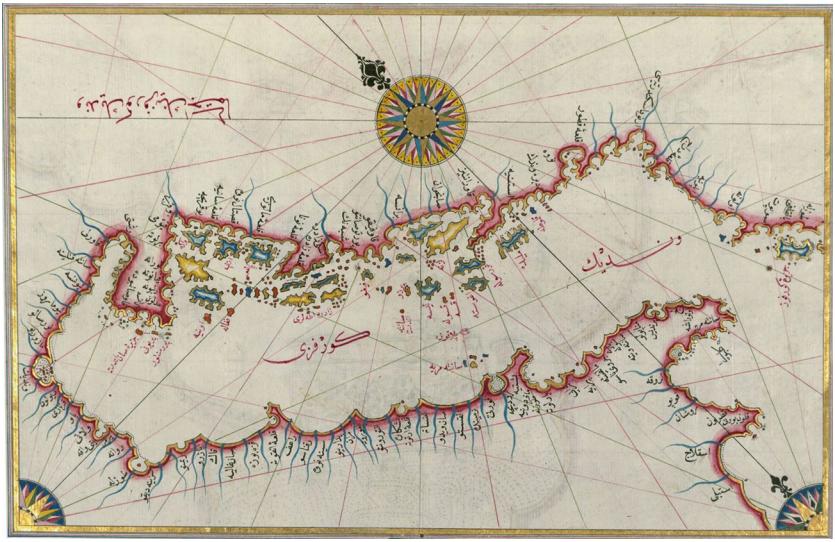

Fig. 1.8 Muhiddin Pîrî Reis, nautical chart of the Adriatic Sea, Gallipoli, 1526 (Source: The Walters Art Museum, Baltimore; W.658, fol. 208a)

cartographers from other parts of Europe often copied their geographical content. Consequently, it is not surprising that Dutch, French, English, and other cartographers did not depict the Adriatic any better than their Venetian predecessors or contemporaries. This is easily confirmed by comparing the shape of the mainland and island coastline contours, and the geographical names found on the Venetian nautical charts with the equivalent elements found on nautical charts made by non-Venetian cartographers. Nevertheless, until the early nineteenth century there were no significant improvements in the accuracy of coastline representation or geographical names, with the exception of the marking of sea depths in more detailed representations of individual Adriatic harbours that have been mapped to a larger scale. For example, the manuscript (portolan) charts of the Adriatic Sea from the sixteenth and seventeenth centuries—made by Battista Agnese (1538), Diogo Homem (1570), Vincus Demetrius Voltius (1593), and Marcheto Fassoi (1679)—hardly differ in their geometry and their geographical content overall (see Fig. 1.9), whose immense geometric resemblance was cartometrically examined in detail (Marelić 2023a, b, 2024a). Although Agnese, Homem, and Fassoi produced their charts in Venice, Agnese was of Genoese origin, whereas Homem came to Venice from Portugal. Voltius made his 1593 chart in Naples, although he also worked in Livorno, and his origins were from the Republic of Ragusa, a city-state that was a political rival of the Republic of Venice at the time. Fassoi's chart of the Adriatic, also made in Venice, was created around a century later and represents a nearly identical copy of its coastline renderings.

Up to the end of the eighteenth century, along with their Venetian counterparts, French cartographers showed the most intense interest in the Adriatic. In their nautical atlases of the Mediterranean and Adriatic Seas, they retained the "Venetian image" of the Adriatic while introducing newly made large-scale renderings of individual Adriatic harbours. Detailed depictions of the larger Adriatic harbours and a general depiction of the entire Adriatic Sea (Fig. 1.10) were published in *Description Géographique du Golphe de Venise et de la Morée*, made by the French cartographer and King's hydrographer Jacques Nicolas Bellin in Paris in 1771, and in *Recueil des Principaux Plans des Ports et Rades de la Mer Mediterranée*, made by the French royal hydrographer Joseph Roux in Marseilles in 1764, whose second edition was published in Genoa in 1779. Jean Joseph Allezard published a revised edition of Roux's work in Genoa in 1804. The nautical charts and plans in these publications did not change the

Fig. 1.9 Four portolan charts of the Adriatic Sea with nearly identical coastline renderings: (**a**) Battista Agnese, 1538 (Source: University of Pennsylvania, Kislak Center for Special Collections, Rare Books and Manuscripts, Philadelphia; LJS 28), (**b**) Diogo Homem, 1570 (Source: Croatian State Archives, Cartographic Collection, Zagreb; HR-HDA-902, D.XIV.6), (**c**) Vincus Demetrius Voltius, 1593 (Source: National Library of Finland, Maps, The Nordenskiöld Map Collection, Helsinki; N-Kt-103c), (**d**) Marcheto Fassoi, 1679 (Source: The Huntington Library, Art Museum, and Botanical Gardens, Library Collections, Maps and Atlases, Portolans, San Marino, CA, USA; mssHM 30)

overall cartographic perception of the Adriatic Sea basin and were not able to meet the concurrent, more sophisticated demands for reliable and geodetically well-defined cartographic frameworks. Bellin's chart from 1771 contains one of the earliest known pieces of information about the contemporary values of magnetic declination for the Adriatic Sea (see enlarged circular inset in Fig. 1.10). As far as is known to the authors, the earliest known cartographic representation of magnetic declination for the Adriatic area is V. M. Coronelli's large-scale chart of the Sazan island (*Saseno*) (Figs. 1.3 and 1.11), published in his Isolario *Mari, Golfi, Isole, Spiaggie,*

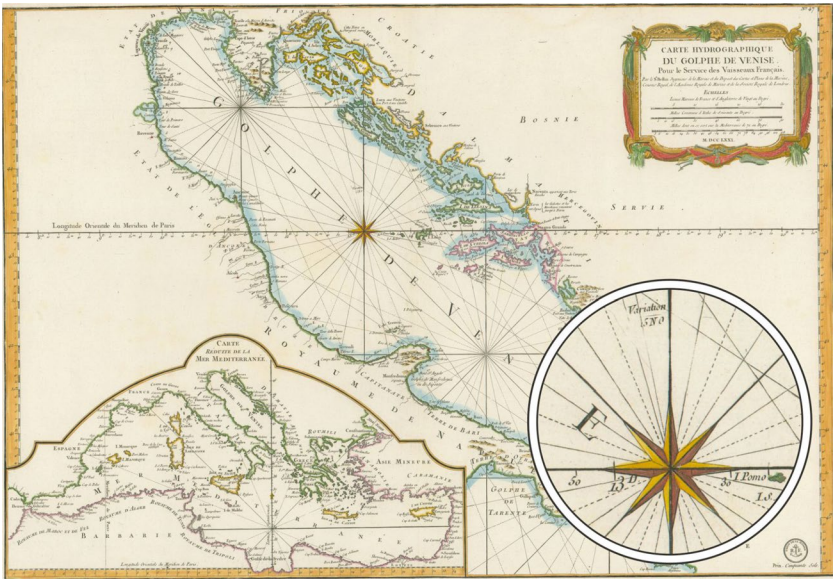

Fig. 1.10 Jacques-Nicolas Bellin, *Carte hydrographique du Golphe de Venise*, Paris, 1771, containing magnetic declination data for the Adriatic Sea area; see enlarged circular inset (Source: National and University Library, Map and Atlas Collection, Zagreb; S-JZ-XVIII-145)

Porti, Citta, Fortezze, Ed altri Luoghi Dell'Istria, Quarner, Dalmazia Albania Epiro, e Livadia, Delineati, e Descritti Dal P. Generale Coroneli (1690–94) (Marelić and Faričić 2023).

1.3 Demands for a More Accurate Representation

Due to the fact that no systematic geodetic or hydrographic surveys were conducted in the Adriatic region before the early nineteenth century, its cartographic representations remained notably anachronistic, retaining a style and geographic content that had changed little since late medieval times. Even the nautical charts of the Adriatic that were produced in the late eighteenth and early nineteenth centuries and published with pretentious claims to be "new" (*nuova carta marittima*) did not make any significant contributions to the development of nautical cartography. Some more renowned examples of such practice are charts published by Ludovico

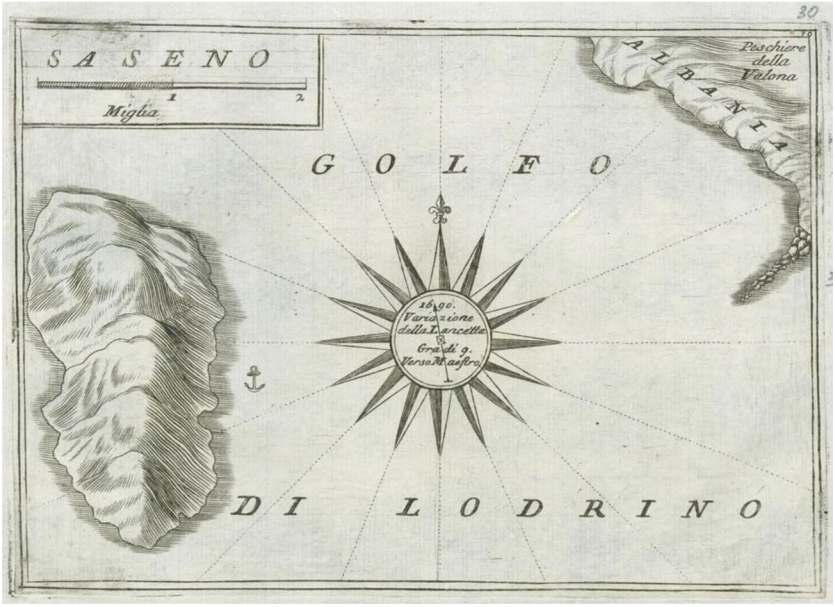

Fig. 1.11 Vincenzo Maria Coronelli's nautical chart (1690–1694) of the Sazan island (Chart source: Vincenzo Maria Coronelli, Isolario, Vol. IV, Venice, 1690–1694 (Source: State Archives in Zadar, Library, Zadar; II.A*)

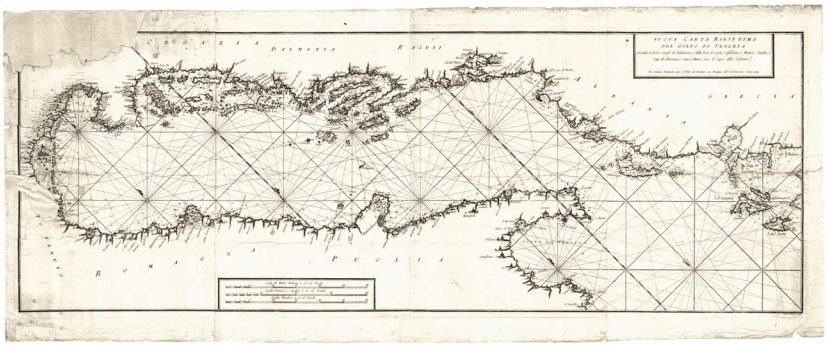

Fig. 1.12 Lodovico Furlanetto, *Nuova carta Marittima del Golfo di Venezia*, Venice, 1784—a medieval nautical cartographic image of the Adriatic Sea in a printed edition from the end of the early modern period (Source: State Archives in Zadar, Cartographic collection, Zadar; HR-DAZD-383 No. 3.1)

Furlanetto in 1784, Vincenzo De Lucio from 1794 to 1796, and Giovanni Grubas in 1809 (Rossit et al. 2006). On Furlanetto's 1784 nautical chart (Fig. 1.12), the only major supplement in terms of geographic content compared to late medieval nautical charts was his marking of sea depths. From 1794 to 1796 De Lucio provided a more accurate and detailed cartographic depiction of the Adriatic (in nineteen sheets) in comparison to Furlanetto's 1784 chart. In 1809, Grubas published new nautical chart of the Adriatic Sea (based on De Lucio's observations and his charts). In spite of its self-congratulatory aspects, it contains many errors that were later rightly pointed out by the English hydrographer and cartographer William Henry Smyth in his overview of charting the Mediterranean in the modern era (Smyth 1854). In terms of their quality in comparison with the 1784, 1794, and 1809 nautical charts, the charts in the *Atlante Marittimo delle due Sicile*, made by Giovanni Antonio Bartolomeo Rizzi Zannoni and published in Naples in 1792, were more accurate. Pursuant to field observations he conducted, Rizzi Zannoni depicted the southwest side of the Adriatic, which belonged to the Kingdom of the Two Sicilies, in great detail (Valerio 2006). His cartographic achievement is considered one of the best of the late eighteenth century (Tooley 1962). However, its content does not encompass the entire Adriatic area.

The turning point in Adriatic cartography, following earlier partial, though scientifically based surveys during the French administration, was mostly the result of work led by Ferdinando Visconti and Charles François Beautemps-Beaupré in 1806 and 1808–1809 (Kozličić 2006; Valerio 2006; Faričić and Mirošević 2017) and was denoted by the first systematic hydrographic survey, which covered the entire Adriatic Sea and resulted in the publication of the *Carta di cabottaggio del Mare Adriatico* in Milan in 1824 (see Fig. 1.3). This achievement was the result of cooperation between institutions in three states—the Austrian Empire, the Kingdom of the Two Sicilies (Kingdom of Naples), and the United Kingdom of Great Britain and Ireland—and was the first international scientific campaign in the field of cartography. The survey was coordinated by Antonio Campana, Director of the Military-Geographic Institute in Milan (Marieni 1830; Smyth 1854; Valerio 2006). Captain Smyth, on behalf of the Hydrographic Office of the Admiralty of the United Kingdom of Great Britain, in his review of preparations for a hydrographic survey of the Adriatic Sea, cited Captain Thomas H. Hurd, who had said during a presentation at the Admiralty: "All the charts of the Adriatic that I have seen are erroneous in regard to its eastern shores… I would therefore recommend a survey to be undertaken" (Smyth 1854: 364). One of the

participants in the surveys of the Adriatic during 1818 and 1819 was Giacomo Marieni, who likewise could not understand the lack of accurate charts of the Adriatic. In the *Portolano del Mare Adriatico* published by the Military-Geographic Institute in Milan in 1830, Marieni wrote: "The Venetians, who along with their well-known success, have dominated the Adriatic for several centuries, for some reason, whether because the times were like that, or perhaps because of the doubtful character of the Republic, which is not for us to judge, never considered producing nautical charts of their shores, which are so desired by all sailors who have gained experience in other seas and know they can make sailing more pleasant, safe, and quick" (Marieni 1830: VI).[1] Hurd and Marieni's statements indicate there was stagnation in terms of developing the nautical cartography of the Adriatic Sea during the eighteenth century. The publication of the *Carta di cabottaggio del Mare Adriatico* allowed sailors to resolve various navigational tasks for the first time using highly accurate nautical charts, marking the demise of early modern nautical cartography, as nautical charts have since been produced by geodetic and hydrographic state offices rather than small, often family-run workshops based on their directors' authority (Faričić 2011; Mlinarić and Miletić Drder 2017).

2 The Spectrum of Scholarly Approaches and Methods

Nautical charts played a pivotal role in the early modern period, which explains their prominence as research subjects across various scholarly fields, particularly geography, cartography, and history. The available academic literature demonstrates that numerous studies have focused on early modern nautical charts of the Adriatic Sea, thereby advancing our understanding of both their production processes and the geographical information they convey. In the history of cartography-related monographs, these charts are generally examined as part of the broader body of old maps depicting the Adriatic, regardless of their specific type or origin.

[1] Marieni's original statement in Italian: "I Veneziani, i quali dominarano d' Adriatico per alcuni secoli, e con quella fortuna che ognun sa, qualunque ne fosse la causa, o la condizione de' tempi, o forse l' indole sospettosa della repubblica, chè a noi non septta do far simili ricerche, non hanno mai pensato alla Carta nautica delle loro coste, tanto desiderata, e massime da que' navigatori che già sapevano per esperienza fatta in altri mari quanto avrebbe giorato al comodo, alla sicurezza de' viaggi, e a renderli più spediti" (Marieni 1830: VI).

2.1 Studies Related to the Adriatic Area

Old nautical charts can be studied from various standpoints and with various aims, examining their extremely varied communication capacities, particularly as part of recent cartographic discourse regarding multiple readings and interpreting the symbolic strength of extra-contextual communication (Panofsky 1970; Mlinarić and Miletić Drder 2017). In general, maps are rich, multi-layered sources of information about the depicted areas, the methods used to create them, their authors, and the circumstances of their production (Bagrow and Skelton 1985). In addition, by applying the principle of analogy to iconographic or imagologic interpretation, including decomposition or deconstruction (Harley 1988, 1989; Monmonier 1996; Dukić et al. 2009; Mlinarić and Gregurović 2011; Mlinarić 2012; Šakaja 2015), it is possible to read old maps in terms of their symbols (Fürst-Bjeliš and Zupanc 2007). Starting from research achievements so far and the discourse tenets of a "new cultural cartography" (Harley 1988, 1989), and pursuant to the interdisciplinary approach that acknowledges geographic, historiographic, geodetic, and nautical discourses, it is necessary to supplement the existing knowledge of early modern nautical charts of the Adriatic Sea, particularly in terms of applying cartometric analyses and evaluating cartographic sources as media of communicating in space and about space.

One of the earliest such works was *Alte handschriftliche Schifferkarten in den Bibliotheken zu Venedig* by Petar Matković, written in 1862, in which he described manuscript nautical charts in the Venetian archives and libraries (Matković 1862). Adolf Erik Nordenskiöld used Matković's work as a source in *Periplus: An Essay on the Early History of Charts and Sailing-Directions* in 1897 (Nordenskiöld 1897). This is a monumental work, a synthesis of all the author's known information on links between seafaring and nautical cartography, beginning in classical times and ending in early modern geographic discoveries by European seafarers in the polar areas and Pacific Ocean. Although the book does not dedicate a separate chapter to the Adriatic Sea and its depiction on nautical charts, it is mentioned several times in the wider context of nautical issues. The book also contains 60 tables and reproductions of numerous nautical charts, many of which depict the Adriatic, either separately or as part of a larger spatial extent. Other significant contributions at that time, works on old nautical charts that appeared in the late nineteenth and early twentieth centuries, include *Sammlung mittelalterlicher Welt-und Seekarten italienischen*

Ursprungs und aus italienischen Bibliotheken und Archiven by Theobald Fischer (1886), *Die italienischen Portolane des Mittelalters. Ein Beitrag zur Geschichte der Kartographie und Nautik* by Konrad Kretschmer (1909), and *Portolan Charts—Their Origin and Characteristics with a Descriptive List of Those Belonging to The Hispanic Society of America* by Edward Luther Stevenson (1911). Relatively newer works of this kind include chapters from the book series *The History of Cartography* published by the University of Chicago Press. Chapters in this series that are most closely related to the nautical cartography of the Late Middle Ages and early modern period are *Portolan Charts from the Late Thirteenth Century to 1500* by Tony Campbell (1987), *The Renaissance Chart Tradition in the Mediterranean* by Corradino Astengo (2007), and *Maps and Exploration in the Sixteenth and Early Seventeenth Centuries* by Felipe Fernández-Armesto (2007). Among more recent syntheses, *Rhumb Lines and Map Wars: A Social History of the Mercator Projection* by Mark Monmonier (2004) and *Les cartes portolanes: la representació medieval d'una mar solcada* by Ramon J. Pujades i Bataller (2007) are prominent.

More detailed overviews of the development of nautical charts of the Adriatic Sea can be found in *Imago Adriae* by Luciano Lago (1998), *Imago Italiae* by L. Lago et al. (2002), *Coste del Mediterraneo nella cartografia europea: 1500–1900* by Paola Presciuttini (2004), *Descriptio Croatiae* by Mirko Marković (1993), and *Kartografski spomenici hrvatskoga Jadrana* by Mithad Kozličić (1995), along with a book entitled *Five Centuries of Maps and Charts of Croatia* edited by Drago Novak, Miljenko Lapaine, and Dubravka Minarić (2005), the monograph *Povijesna kartografija: kartografski izvori u povijesnim znanostima* by Mirela (Slukan) Altić (2003), and the monograph *Zbirka Novak: Mappae Croaticae u Zbirci zemljovida i atlasa NSK* by D. Mlinarić and Mira Miletić Drder (2017).

Many academic papers have been published on nautical charts of the Adriatic Sea, or on particular aspects of such charts. Italian scholars, such as Roberto Almagia, wrote many prominent works, including one on the nautical charts in the Apostolic Library in the Vatican (Almagia 1944). L. Lago and Claudio Rossit have dealt exhaustively with the nautical cartography opus of Pietro Coppo (Lago and Rossit 1984), while Rossit and others produced an overview of depictions of the Adriatic on old maps, including some nautical charts (Rossit et al. 2006). Vladimiro Valerio published several works with the results of his research into charting the Adriatic, some of which were the result of activities in which the Kingdom

of Naples participated (Valerio 2006), and Orietta Selva researched Venetian cartography as a symbol of power and means of planning (2013). Kozličić has made some of the greatest contributions in the field of nautical cartography of the Adriatic. His preoccupation is with contextualising nautical charts as sources from which the developmental trajectory of geographic and oceanographic knowledge of the Adriatic can be traced (Kozličić 1999; Kozličić and Faričić 2004, 2016), and in particular, the hydrographic survey of the eastern Adriatic coast conducted in two separate campaigns under the leadership of Charles François Beautemps-Beaupré (Kozličić 2006). Kozličić has also correlated nautical charts and sailing manuals, which together form a functional whole (Kozličić et al. 2012; Kozličić 2013; Kozličić and Uglešić 2015). Dušanka Čanković has given a succinct historiographic overview of the development of the nautical cartography of the Adriatic from the late fifteenth to the early nineteenth century (Čanković 1987, 2005). The works of M. (Slukan) Altić are particularly valuable, such as those on the development of portolan charts (Slukan Altić 1998, 2003) and on the British, Austro-Hungarian, and Italian contributions to the development of the nautical cartography of the Adriatic (Slukan Altić 2016; Altić 2021). More recently, Josip Faričić, Lena Mirošević, Ivka Kljajić, and D. Mlinarić examined the use of compass roses on nautical charts of the Adriatic Sea (Faričić et al. 2023a), whereas J. Faričić, O. Selva, and Dragan Umek studied geographical names of the Adriatic Sea on old maps and nautical charts (Faričić et al. 2023b). These works are dominated by the descriptive historiographic approach and a qualitative analysis of various spatial data, particularly toponyms, but they fail to include a quantitative cartometric analysis of nautical charts, in the sense of establishing their mathematical and geodetical basis (particularly map projections and scales), which is key to understanding their applicability as reliable sources of information to be used for planning and implementing various navigational tasks. Tome Marelić's doctoral thesis (Marelić 2020), published as three articles (Marelić 2022a, b, 2024a), is the sole extensive and detailed cartometric study of late medieval and early modern nautical charts for the Adriatic Sea in existence. Additional information on cartometric analyses and notable works can be found in a separate section of this chapter.

Croatian historians of cartography have so far paid little attention to reading old nautical charts as sources for establishing concepts of information organisation and imagining the Adriatic Sea as an area of multiple socioeconomic and particularly political and cultural permeation, but this

has been done, at least for individual parts of Croatia, in research into early modern geographic maps (Fürst-Bjeliš 2009, 2012; Mlinarić 2012, 2014; Mlinarić and Gregurović 2011). In fact, up to the sixteenth century, Croatia was not shown on large-scale maps, which was not unusual. It was only in the late fifteenth century and early sixteenth century that maps of the region of European states began to be produced, including Croatia and the neighbouring areas of modern Italy and Hungary (Bagrow and Skelton 1985). This initiative in European cartography was prompted on the one hand by the publication of Ptolemy's *Geographia*, with the development of science and the aim of acquiring and depicting new geographic spatial knowledge, and the needs of states and lower levels of government to visualise their territories or the spatial resources at their disposal on the other (Woodward 2007). In terms of the cartographic depiction of individual regional units on the eastern Adriatic coast, we should add the increased interest of European political and cultural centres in understanding the arenas of conflict between the imperial powers of Venice, the Habsburg Monarchy, and the Ottoman Empire (Fürst-Bjeliš and Zupanc 2007; Mlinarić 2014; Mirošević and Faričić 2015). These powers confronted each other with varied outcomes, attempting by different means, including maps, to present their agendas or at least their perceptions of their borders, in order to achieve their political and economic strategies (Mlinarić and Gregurović 2011). During the entire early modern period, this left a strong imprint on the landscape and identity of the Dalmatian coastal area, the contact point for the intermingling of various ethnic, religious, and linguistic structures (Fürst-Bjeliš 2009, 2012). It was logical to expect that nautical charts would also become a medium for transmitting various political messages and not merely navigational tools in the hands of sailors.

2.2 Qualitative Approaches to the History of Nautical Cartography

In the contemporary research discourse on reading cartographic sources and their trans-media and trans-genre comparison with other types of visual and narrative historical documents, maps are seen critically as subjective, authorial products that may, but need not, reflect historical truths, at least not generally accepted ones (Brković and Mlinarić 2013). In any case, they reflect the attempt to communicate ideas and concepts (geographic, cultural, geostrategic, in relation to political propaganda,

economic, linguistic, ethnic, demographic, and so on) by the people who commissioned them or financed them, and, indirectly, by the authors themselves. In this context, nautical charts were a sophisticated means of expressing the mutual relationships and aspirations of the European political elite, conveyed in coded messages. At the same time, as sources, they imply a certain level of speculation as to their historical witness and are of dubious reliability, although due to their very existence, they are, in a sense, exact, credible historical sources, even when their credibility relates primarily to their intention or aim (Mlinarić and Miletić Drder 2017).

The subjectivity within the mapmaking, which was profound before the implementation of systematic field surveys, was conditioned not only by cartographers' professional competence and their personal preferences but also by the particular purpose of the map and the motifs and interests of the person or institution who commissioned its creation. The purpose of charts and maps was not only to present the best possible depiction of geographical reality but also to shape the reality in accordance with certain political aspirations and economic interests. This can be seen, for example, in the drawing of political boundaries (deliberately anachronistic in terms of changes and new situations that were not accepted for state or legal reasons), the use of geographic names, etc. For example, the reasons behind the Venetian cartographer's decision to write *Golfo di Venezia* for the entire Adriatic Sea are fully internal in terms of contemporary politics, whereas the names *Golfe de Venise* and *Gulph of Venice*, used by French and English cartographers, are adoptions of externally established political narratives. The Venetian cartographers were, thus, emphasising and promoting the current territorial aspirations of the Republic of Venice, whereas the syntagm "Adriatic Sea" was understood as its historical name from classical antiquity (e.g. on his 1688 map of the Adriatic Sea and the surrounding areas, V. M. Coronelli wrote: *Golfo di Venezia olim Adriaticum Mare*, meaning *The Gulf of Venice once upon a time the Adriatic Sea*). The French, English, and other Western European cartographers adopted the Venetian name mostly because they used charts and maps made by the Venetian authors as templates. At the same time, the Austrian cartographers, who refused to acknowledge the dominance of Venice in the Adriatic, called it by its older, politically neutral name—*Mare Hadriaticum*, or *Mare Adriaticum* (Ger. *Adriatisches Meer*, It. *Mare Adriatico*) (Faričić et al. 2023b).

The geographical content of early modern nautical charts of the Adriatic Sea should be studied with regard to the perspective of how geographical

reality was observed and cartographically visualised. The working hypothesis is that the geographic content of nautical charts was conditioned by the amount and quality of the geographical knowledge and from the estimated motifs and reasons for its creation. Therefore, distinct perspectives (of their authors) yield different perceptions of the (same) reality (Todorova 2015), whereas modern epistemology, in an era of different spatial (Space Turn) and similar interpretative reversals that critically examine but also build on Fernand Braudel's concepts of endurance (Braudel 1972), defines spaces as a cultural triad. It simultaneously comprises actual (physical space), intellectually processed mental space, and, finally, the living "third-space." It is characterised by various symbolic meanings, ranging across the material, hybrid, and the representative, particularly when depicted on maps as visual historical sources (Cosgrove 2004; Crampton 2009; Soja 2001).

The quality and range of geographic content on old nautical charts should be considered within the context of the socioeconomic settings of the time, which affected the competence, perspectives, and motifs of their authors. It is logical to assume that cartographers' decisions regarding which geographical features are going to be drawn on the map depended on their spatial relevance—both in terms of their actual size and in terms of their perceived importance (political, navigational, etc.), which do not always coincide. While the physical dimensions, such as lengths or areas, are relatively easy to understand, observe, and even survey, the importance is a non-quantifiable subjective category that varies on an individual basis, especially between those who assess it internally or externally. Rob Kitchin and Martin Dodge have stated quite correctly that "maps are transitory and fleeting, being contingent, relational, and context-dependent" (2007: 335). Modern theories in cartography recognise that maps (whether early modern or modern) provide their authors with liberties to lie about historical and more recent events with ease, despite all the advances of science and human self-assurance (Monmonier 1996; Mlinarić and Gregurović 2011).

By conducting a comparative analysis of early modern nautical charts of the Adriatic Sea and applying a method of deconstruction or "decomposition," this study investigates the perception of the actual geographical space. The findings show that this perception was influenced by the methods used to collect spatial data, the extent and quality of geographical knowledge, and the perspectives from which the Adriatic area was viewed. Different perceptions of the Adriatic reveal diverse ideas, concepts,

discourses, and biases (e.g. regarding spatial organisation along core–periphery lines, "Us" vs. "Others," East vs. West, etc.).

On old cartographic representations of the Adriatic, authors or commissioners expressed their intentions by employing suggestive generalisations—highlighting or concealing particular elements of geographical reality—and incorporating iconographic features whose rich symbolism exceeded mere aesthetic (decorative) purposes. The early modern nautical charts of the Adriatic Sea serve as a good example of the interplay between realistic and imaginary content, which intertwines to form complex composites. In these composites, one can discern far more than is revealed by a straightforward interpretation of what and where things are depicted on the charts.

2.3 Quantitative Approaches to the History of Nautical Cartography

Cartometric analyses, a relatively new approach and less frequently conducted in comparison to traditional qualitative academic publications, occupy a distinct niche in the history of cartography studies. In the context of old nautical cartography, a certain number of notable works examine late medieval and early modern portolan charts, usually in the form of comprehensive studies, some of which are still ongoing (Loomer 1987; Nicolai 2014, 2015, 2016, 2024; Marelić 2024b, c, 2025a, b).

Cartometric analysis is an umbrella term for various quantitative methods used to estimate the geometric properties of maps (its most plausible map projection, its map scale, etc.). In the late nineteenth century, Hermann Wagner was the first person to implement his method with the aim of establishing the geometric features of medieval portolan charts and coined the term "cartometric method" (Wagner 1896/1969). These methods were further facilitated by the development of information technology in the latter part of the twentieth century, and one of its first adopters was Waldo R. Tobler. In 1966, he utilised a computerised method to assess the geometric properties of old maps and examined Pietro Roselli's 1468 portolan chart (Tobler 1966), whereas in 1977, he proposed the concept of the empirical map projection (Tobler 1977). During the late twentieth century, more intensive development of computer technology expanded the possibilities of cartometric approaches, and one of the most comprehensive studies of the time is Scott A. Loomer's doctoral dissertation *A Cartometric Analysis of Portolan Charts: a Search for Methodology*

(Loomer 1987). Cartometric studies of old charts and maps intensified in the twenty-first century, resulting in an increased number of journal publications (Balletti 2006; Gaspar 2007, 2008, 2013; Gaspar and Leitão 2014; Rajaković et al. 2014; Nicolai 2015, 2018, 2024; Balletti and Gottardi 2015; Livieratos and Boutoura 2018; Marelić 2024a, b, c). These publications range from overviews of theoretical works on the general benefits of georeferencing old maps to exact results achieved by applying cartometric analyses. Some of these works stem from the usage of the *MapAnalyst* cartometric freeware, produced by the Institute of Cartography of ETH Zurich. The software is based on algorithms developed by Dieter Beineke (2001; Jenny 2006; Jenny and Hurni 2011) and provides some basic tools for cartometric analyses, but it is not suitable for examining maps with large longitudinal coverage (Jenny 2010; Nicolai 2018). In contrast, more comprehensive and detailed cartometric studies are carried out employing more advanced GIS and statistical software—none of which is designed specifically for cartometric purposes—allowing the geometry of the old charts and maps to be iteratively compared to the multiple and customisable coordinate reference systems of the modern map.

References

Abulafia D (2011) The Great Sea: a human history of the Mediterranean. Oxford University Press

Almagia R (1944) Carte nautiche e affini dal secolo XIV al XVII esistenti nella Biblioteca Apostolica Vaticana, Monumenta cartografica vaticana, I. Citta del Vaticano

Altić M (2021) Charting newly created statehood: a maritime survey of the Adriatic by the Joint Forces of the Austro-Hungarian and Italian Hydrographic Offices. Cartograph J 58(1):13–28. https://doi.org/10.1080/00087041.2019.1685288

Astengo C (2007) The renaissance chart tradition in the mediterranean. In: Woodward D (ed) The history of cartography, Vol. 3, Part 1—cartography in the European Renaissance. University of Chicago Press, Chicago, pp 174–262

Bagrow L, Skelton RA (1985) History of cartography. Harvard University Press

Balletti C (2006) Georeference in the analysis of the geometric content of early maps. e-Perimetron 1(1):32–42

Balletti C, Gottardi C (2015) Analytical methods for the projective content of Coronelli's central Europe maps. In: Arbore-Popescu G, Dabalà C (eds) The cartography of the Danube and the surrounding areas in and after the times of Vincenzo Maria Coronelli and Luigi Ferdinando Marsili. Corilia, pp 23–33, 87–93

Beineke D (2001) Verfahren zur Genauigkeitsanalyse für Altkarten. Doctoral thesis. Universität der Bundeswehr München

Berggren JL, Jones A (2000) Ptolemy's geography: an annotated translation of the theoretical chapters. Princeton University Press, Princeton

Braudel F (1972) The Mediterranean and the Mediterranean World in the Age of Philip II, vol 1. Harper & Row

Brković I, Mlinarić D (2013) Reprezentacija Dubrovnika u književnosti i kartografiji 17. stoljeća. Književna istorija: časopis za nauku o književnosti 149(45):29–53

Campbell T (1987) Portolan Charts from the Late Thirteenth Century to 1500. In: Harley JB, Woodward D (eds) The history of cartography, Vol. 1—cartography in prehistoric, ancient and Medieval Europe and the Mediterranean. University of Chicago Press, pp 371–463

Cartwright W (2009) Art and cartographic communication. In: Cartwright W, Gartner G, Lehn L (eds) Cartography and art. Springer, pp 9–22

Chaline O, Doumerc B, Ducellier A, Sivignon M (2001) Histoire de l'Adriatique. Seuil

Claus S, De Hauwere N, Vanhoorne B, Souza Dias F, Oset García P, Schepers L, Hernandez F, Mees J (Flanders Marine Institute) (2017). MarineRegions.org

Cosgrove D (2004) Landscape and landschaft. German Hist Instit Bull 35:57–71

Cotrugli B (1464) De Navigatione Liber. Yale University, Beinecke rare book and manuscript library, Call No.: MS 557 (https://collections.library.yale.edu/catalog/2005406)

Crampton JW (2009) Cartography: performative, participatory, political. Progr Hum Geograph 33(6):840–848. https://doi.org/10.1177/0309132508105000

Čanković D (1987) Jadranska obala na zemljopisnim kartama do početka 19. stoljeća u kontekstu razmatranja—karta kao kartografsko i estetsko djelo. Vjesnik bibliotekara Hrvatske 30(1-4):45–56

Čanković D (2005) Five centuries of the Adriatic on maps. In: Novak D, Lapaine M, Mlinarić D (eds) Five centuries of map and charts of Croatia. Školska knjiga, pp 202–224

Dilke OAW (1985) Greek and Roman maps. Cornell University Press, Ithaca, NY

Dukić D, Blažević Z, Plejić Poje L, Brković I (eds) (2009) Kako vidimo strane zemlje: uvod u imagologiju. Srednja Europa

Faričić J (2011) Kartografske aktivnosti u Dalmaciji tijekom francuske uprave 1806.—1813. In: Šanjek F (ed) Hrvati i Ilirske pokrajine. Hrvatska akademija znanosti i umjetnosti, pp 353–377

Faričić J, Mirošević L (2017) Carta di cabotaggio del Mare Adriatico (1822-1824). A turning-point in the development of Adriatic maritime cartography. Imago Mundi 69(1):99–111. https://doi.org/10.1080/03085694.2017.1242846

Faričić J, Kljajić I, Mirošević L, Mlinarić D (2023a) Symbolism of compass roses on early modern nautical charts of the Adriatic Sea. KN-J Cartograph Geograph Inf 73(1):19–37. https://doi.org/10.1007/s42489-022-00129-z

Faričić J, Selva O, Umek D (2023b) Geographical names of the Adriatic Sea on medieval and early-modern maps and nautical charts. J Hist Geograp 82:68–80. https://doi.org/10.1016/j.jhg.2023.09.007

Faričić J, Lončar I (2024) Jadranski otoci u Općem izolaru svih otoka svijeta Alonsa de Santa Cruza. Radovi Zavoda za povijesne znanosti HAZU u Zadru 66:41–81. https://doi.org/10.21857/yl4okf8dx9

Fernández-Armesto F (2007) Maps and exploration in the sixteenth and early seventeenth centuries. In: Woodward D (ed) The history of cartography, Volume 3, Part 1—Cartography in the European Renaissance. University of Chicago Press, pp 738–770

Fischer T (1886) Sammlung mittelalterlicher Welt-und Seekarten italienischen Ursprungs und aus italienischen Bibliotheken und Archiven. Ferdinand Ongania

Fürst-Bjeliš B (2009) Slike i mijene regionalnoga identiteta: geografska imena na kartama ranoga novoga vijeka (odabrani primjeri). In: Skračić V, Faričić J (eds) Geografska imena—Zbornik radova s Prvoga nacionalnog savjetovanja o geografskim imenima. Svečuilište u Zadru and Hrvatsko geografsko društvo, pp 63–68

Fürst-Bjeliš B (2012) Imaging the past: cartography and multicultural realities of Croatian realities. In: Bateira C (ed) Cartography—a tool for spatial analysis. Intech Open, pp 295–312

Fürst-Bjeliš B, Zupanc I (2007) Images of the Croatian Borderlands: selected examples of early modern cartography. Hrvatski geografski glasnik 69(1):5–19. https://doi.org/10.21861/HGG.2007.69.01.01

Gaspar JA (2007) The myth of the square chart. e-Perimetron 2(2):66–79

Gaspar JA (2008) Dead reckoning and magnetic declination: unveiling the mystery of portolan charts. e-Perimetron 3(4):191–203

Gaspar JA (2013) From the portolan chart to the latitude chart. Cartes et Géomatique, Comité Français de Cartographie 216:67–77

Gaspar JA, Leitão H (2014) Globes, Rhumb Tables, and the pre-history of the Mercator projection. Imago Mundi 66(2):180–195. https://doi.org/10.1080/03085694.2014.902580

Gautier Dalché P (1995) Carte marine et portulan au XIIe siècle. Le Liber de Existencia Riverierarum et Forma Maris Nostri Mediterranei (Pise, circa 1200). École Française de Rome

Gautier Dalché P (2002) Cartes marines, représentation du littoral et perception de l'espace au Moyen Âge. Un état de la question. In: Martin JM (ed) Castrum

VII. Zones côtières et plaines littorales dans le monde Méditerranéen au Moyen Age. École français de Rome and Casa de Velázquez, pp 9–33
Gautier Dalché P (2007) The reception of Ptolemy's geography (end of the fourteenth to beginning of the sixteenth century). In: Woodward D (ed) The history of cartography, Volume 3, Part 1—Cartography in the European Renaissance. University of Chicago Press, Chicago, pp 285–364
Harley JB (1988) Maps, knowledge and power. In: Cosgrove D, Daniels S (eds) The iconography of landscape. Cambridge University Press, pp 277–312
Harley JB (1989) Deconstructing the map. Cartographica 26(2):1–20. https://doi.org/10.3138/E635-7827-1757-9T53
Hewson JB (1983) A history of the practice of navigation. Brown, Son & Ferguson
Ivetic E (2019) Storia dell'Adriatico. Un mare e la sua civiltà. In Mulino, Bologna
Jenny B (2006) MapAnalyst—a digital tool for the analysis of the planimetric accuracy of historical maps. e-Perimetron 1(3):239–245
Jenny B (2010) New features in mapAnalyst. e-Perimetron 5(3):176–180
Jenny B, Hurni L (2011) Studying cartographic heritage: analysis and visualization of geometric distortions. Comput Graph 35:402–411. https://doi.org/10.1016/j.cag.2011.01.005
Karssen AJ (1980) The artistic elements in map design. Cartograph J 17(2):121–127. https://doi.org/10.1179/caj.1980.17.2.124
Keuning J (1955) The history of geographical map projections until 1600. Imago Mundi 12(1):1–24. https://doi.org/10.1080/03085695508592085
Kitchin R, Dodge M (2007) Rethinking maps. Progress Hum Geograph 31(3):331–344. https://doi.org/10.1177/0309132507077082
Kozličić M (1995) Kartografski spomenici hrvatskog Jadrana. AGM
Kozličić M (1999) Izmjere dubina istočnog Jadrana tijekom 16.-19. stoljeća. In: Gereš D (ed) 2. hrvatska konferencija o vodama: Hrvatske vode od Jadrana do Dunava. Hrvatske vode, pp 325–334
Kozličić M (2006) The Eastern adriatic in the work of Beautemps-Beaupré. Croatian Hydrographic Institute, Split
Kozličić M (2013) Pomorske karte i plovidbeni priručnici istočnog Jadrana tijekom povijesti. Miscellanea Hadriatica et Mediterranea 1:169–197
Kozličić M, Faričić J (2016) Značenje Vira u pomorsko-geografskom sustavu Jadrana u prošlosti. In: Magaš D (ed) Otok Vir. Sveučilište u Zadru and Općina Vir, pp 255–276
Kozličić M, Faričić J (2004) The significance of Sveti Andrija Island (Svetac) on a sailing route across the Adriatic presented on old geographical maps. Geoadria 9(1):33–49. https://doi.org/10.15291/geoadria.128
Kozličić M, Faričić J, Uglešić S (2012) Geographical Basis of Navigation along the Velebit Channel according to the 1639 Senj Pilot. Geoadria 17(1):45–71. https://doi.org/10.15291/geoadria.237

Kozličić M, Mlinarić D, Andrić M (2015) The Zadar maritime zone in Pîrî Reis's Book of Navigation of 1526: maritime and geographical images of part of the Croatian Adriatic. Geoadria 20(2):119–147. https://doi.org/10.15291/geoadria.5

Kozličić M, Uglešić S (2015) The early 17th century Senj Pilot. The Velebit Podgorje region between Senj and Dračevac, according to Croatian and German editions of the Senj Pilot, University of Zadar

Kretschmer K (1909) Die italienischen Portolane des Mittelalters. Ein Beitrag zur Geschichte der Kartographie und Nautik. Veröffentlichen des Instituts für Meereskunde und des geographischen Instituts an der Universität Berlin

Krygier JB (1995) Cartography as an art and a science? Cartograph J 32(1):3–10. https://doi.org/10.1179/000870495787073762

Lago L (1998) Imago Adriae—La Patria del Friuli, L'Istria e la Dalmazia nella cartografia antica. La Mongolfiera Libri

Lago L (ed) (2002) Imago Italiae. Fabrica dell'Italia nella storia della cartografia tra Medioevo ed Età moderna. Realtà, immagine e immaginazione dai codici di Claudio Tolomeo all'Atlante di Giovanni Antonio Magini. Università di Trieste e Goliardica Editrice

Lago L, Rossit C (1984) Pietro Coppo. Le "Tabulae" (1524-1526). Una preziosa raccolta cartografica custodita a Pirano. Note e documenti per la storia della cartografia. Lint Editoriale Associati

Livieratos E, Boutoura C (2018) Carte Pisane and its coastline shape. e-Perimetron 13(3):161–181

Loomer SA (1987) A cartometric analysis of Portolan Charts: a search for methodology (doctoral dissertation). The University of Wisconsin

Marelić T (2020) Točnost prikaza Jadranskog mora na portulanskim kartama. Doctoral thesis. University of Zadar

Marelić T (2022a) Conformal cylindrical properties of Adriatic Sea Basin renderings on Portolan Charts. Cartograph J 59(2):83–101. https://doi.org/10.1080/00087041.2021.1956263

Marelić T (2022b) The origin of distance and bearing navigational data contained in portolani for the Adriatic Sea basin. Int J Cartograph (published online 01 April 2022):1–23. https://doi.org/10.1080/23729333.2022.2047402

Marelić T (2023a) Geometric stalemate and de-evolution of Adriatic Sea representations on early modern age nautical charts. Cartograph J 60(3):216–229. https://doi.org/10.1080/00087041.2023.2172533

Marelić T (2023b) Doubly perceived shape of the Adriatic Sea Basin on early modern geographical maps and nautical charts. Kartografija i geoinformacije 22(2):20–41. https://doi.org/10.32909/kg.22.39.2

Marelić T (2024a) Certain arguments against the hypothesis that portolan charts were genuine late-medieval cartographic products. Int J Cartograph 10(1):94–117. https://doi.org/10.1080/23729333.2022.2163146

Marelić T (2024b) Traces of the common origin of Carte Pisane, Cortona Chart and Pietro Vesconte's Charts. KN – J Cartograph Geograph Inf 74(2):137–156. https://doi.org/10.1007/s42489-023-00154-6

Marelić T (2024c) Copying-lineages of Portolan chart metrics and implications of their pre-Medieval origin. Int J Cartograph (published online 16 July 2024):1–26. https://doi.org/10.1080/23729333.2024.2349974

Marelić T (2025a) Mosaics within mosaics: the geometry of Portolan Atlases that contradicts the medieval origin hypothesis. KN – J Cartograph Geograph Inf 75(1):57–78. https://doi.org/10.1007/s42489-024-00176-8

Marelić T (2025b) Are Portolan charts and Portolan mile geometrically rooted in classical antiquity? A cartometric analysis of al-Shirazi's "Greek Map" and the Pisane, Lucca, Avignon, and Cortona Charts. Cartographica 59(4):143–160. https://doi.org/10.3138/cart-2024-0029

Marelić T, Faričić J (2023) Magnetic declination on the early modern cartographic representations of the Adriatic Sea. Abstracts Int Cartographic Assoc 6(155):1–2. https://doi.org/10.5194/ica-abs-6-155-2023

Marieni G (1830) Portolano del Mare Adriatico, Compilato sotto la Direzione dell'Istituto geografico militare dell'I. R. Stato maggiore generale. Imperiale regia stampera

Marković M (1993) Descriptio Croatiae—Hrvatske zemlje na geografskim kartama od najstarijih vremena do pojave prvih topografskih karata. Naprijed

Matković P (1862) Alte handschriftlische Schifferkarten in den Bibliotheken zu Venedig. Mitteilungen der Geographischen Gesellschaft in Wien:79–107

May WE (1973) A history of marine navigation. W. W. Norton & Company

Mirošević L, Faričić J (2015) Reflections of political-geographic shifts in the use of the geographic name 'Dalmatia' on maps in the early modern period. Annales—Series historia et sociologia 25(4):845–860. UDC 912.43(497.58):81'373.21

Mlinarić D (2012) A culture of cartography: maps of the Central Dalmatian Coastland. IMCoS J 129:15–20

Mlinarić D (2014) Stare karte Dalmacije promatrane kroz prizmu neokartografije: Čitanje povijesno-geografskih reprezentacija 16. i 17. stoljeća. In: Mirošević L, Graovac Matassi V (eds) Dalmacija u prostoru i vremenu: Što Dalmacija jest a što nije?. Sveučilište u Zadru, pp 89–100

Mlinarić D, Gregurović S (2011) Kartografska vizualizacija i slika Drugoga na primjeru višestruko graničnih prostora. Migracijske i etničke teme 27(3):345–373

Mlinarić D, Miletić Drder M (2017) Zbirka Novak: Mappae Croaticae u Zbirci zemljovida i atlasa NSK. National and University Library in Zagreb

Mlinarić D, Faričić J (2024) The Eastern Adriatic Coast in the narratives of the early-modern ottoman navigator and cartographer, Piri Reis. In: Ak M, Üstüner A (eds) Geography and Cartography in the Ottoman Empire. Istanbul University Press, pp 381–402. https://doi.org/10.26650/B/AH03AH08.2024.039.012

Monmonier M (1996) How to lie with maps, 2nd edn. University of Chicago Press
Monmonier M (2004) Rhumb lines and map wars: a social history of the Mercator projection. The University of Chicago Press
Nicolai R (2014) A critical review of the hypothesis of a medieval origin for Portolan Charts (doctoral dissertation). University of Utrecht
Nicolai R (2015) The premedieval origin of Portolan charts: new geodetic evidence. ISIS 106(3):517–543. https://doi.org/10.1086/683532
Nicolai R (2016) The Enigma of Portolan Charts—a geodetic analysis of the hypothesis of a medieval origin. Brill-Leiden
Nicolai R (2018) Analysing map analyst and its application to Portolan charts. e-Perimetron 13(3):121–140
Nicolai R (2024) The origin problem of nautical cartography: the importance of evidence and method. Int J Cartograph 1–25. https://doi.org/10.1080/23729333.2024.2352822
Nordenskiöld AE (1897) Periplus: an essay on the early history of charts and sailing-directions. P. A. Norstedt & Söner
Novak D, Lapaine M, Mlinarić D (eds) (2005) Five centuries of map and charts of Croatia. Školska knjiga
Panofsky E (1970 (1955)). Meaning in the visual arts. Penguin.
Presciuttini P (2004) Coste del Mediterraneo nella cartografia europea: 1500-1900. Priuli & Verlucca
Pujades i Bataller RJ (2007) Les cartes portolanes: la representació medieval d'una mar solcada. Lunwerg Editores
Rajaković M, Kljajić I, Lapaine M (2014) Map Projection Reconstruction of a Map by Mercator. In: Buchroithner M, Prechtel N, Burghardt D (eds) Cartography from pole to pole lecture notes in geoinformation and cartography. Springer, pp 31–44
Ribeiro DM, Caquard S (2018) Cartography and art. In Wilson JP (ed) The geographic information science & technology body of knowledge. https://doi.org/10.22224/gistbok/2018.1.4
Rossit C, Selva O, Umek D (2006) Imago Adriae—L'Adriatico e l'Abruzzo nelle antiche carte geografiche. Editrice Sigraf
Selva O (2013) Lo stato della cartografia veneziana tra XVI e XVIII secolo: emblema di potere e strumento di pianificazione territoriale. Bollettino dell'Associazione Italiana di Cartografia 148:69–87. http://hdl.handle.net/10077/12268
Sheehan KE (2012) Utility and aesthetic: the function and subjectivity of two fifteenth-century portolan charts. The Portolan 83:7–23
Shipley G (2011) Pseudo-Skylax's Periplous: the circumnavigation of the inhabited world: text, translation and commentary. Liverpool University Press Series. Bristol Phoenix Press

Slukan Altić M (2003) Povijesna kartografija: kartografski izvori u povijesnim znanostima. Meridijani
Slukan Altić M (1998) Pojava i razvoj portulana s posebnim osvrtom na portulanski atlas Diega Homena. Geodetski List 52(2):99–107
Slukan Altić M (2016) British contribution to the charting of the Adriatic Sea. Cartographic J 53(4):305–317. https://doi.org/10.1080/00087041.2015.1108659
Smyth WH (1854) The mediterranean: a memoir—physical historical and nautical. John W. Parker & Son
Snyder JP (1993) Flattening the earth: two thousand years of map projections. The University of Chicago Press, Chicago
Soja E (2001) Postmodern geographies. The reassertion of space in critical social theory. Verso
Stevenson EL (1911) Portolan charts—their origin and characteristics with a descriptive list of those belonging to The Hispanic Society of America, Publications of The Hispanic Society of America, 82. The Knickerbocker Press
Šakaja L (2015) Uvod u kulturnu geografiju. Leykam International
Taylor EGR (1957) The haven-finding art—a history of navigation from Odysseus to Captain Cook. Abelard-Schuman Ltd. and William Clowes & Sons
Tobler W (1966) Medieval distortions: the projections of ancient maps. Annu Assoc Am Cartographer 56:351–361. https://doi.org/10.1111/j.1467-8306.1966.tb00562.x
Tobler W (1977) Numerical approaches to map projections. In: Kretschmer E (ed) Studies in theoretical cartography. Deuticke, pp 51–64
Todorova M (2015) Imaginarni Balkan, Naklada Ljevak.
Tooley RV (1962) Maps and map-makers. Bonanza Books
Turnbull D (1996) Cartography and science in Early Modern Europe: mapping the construction of knowledge spaces. Imago Mundi 48:5–24. https://doi.org/10.1080/03085699608592830
Vagnon E (2007) Cartes marines et réseaux à la fin du Moyen Âge. In: Coulon D, Picard C, Valéria D (eds) Espaces et Réseaux en Méditerranée VIe—XVIe siècle, Vol. I La configuration des réseaux. Éditions Bouchène, pp 293–308
Vagnon E (2021) Representations. Painting, mapping, re-inventing the seas of the world. In: Lambourn E (ed) A cultural history of the sea II. Bloomsbury Publishing, pp 159–192
Valerio V (2006) Landscapes and charting in the nineteenth century Neapolitan-Austrian and English cooperation in the Adriatic Sea. In: van Gestel-van het Schip P, van der Krogt P (eds) Mappae Antiquae—Liber Amicorum Günter Schilder. HES & De Graaf Publishers, pp 465–478
Stouraiti A (2013) Talk, script and print: the making of island books in early modern Venice. Hist Res 86(232):207–229. https://doi.org/10.1111/1468-2281.12014

Tolias G (2007) Isolarii, fifteenth to seventeenth century. In: Woodward D (ed) The history of cartography, 3: Cartography in the European renaissance. University of Chicago Press, pp 263–284

Wagner H (1896) The origin of the mediaeval Italian nautical charts. Report of the sixth international geographical congress, pp 695–705. Royal Geographical Society, reprint in: Acta Cartographica, 5 (1969), 476–485

Wintle M (1999) Renaissance maps and the construction of the idea of Europe. J Hist Geograph 25(2):137–165. https://doi.org/10.1006/jhge.1999.0111

Woodward D (2007) Cartography and the Renaissance: Continuity and Change. In: Woodward D (ed) The history of cartography, Vol. 3, Part 1—Cartography in the European Renaissance. University of Chicago Press, pp 3–24