

MARITIME HUMANITIES, 1400-1800



Mauricio Nieto Olarte

Exploration, Religion and Empire in the Sixteenth-century Ibero-Atlantic World

A New Perspective on the History
of Modern Science

Amsterdam
University
Press

A
X
U
X
P
X

Amsterdam
University
Press

Exploration, Religion, and Empire in the
Sixteenth-century Ibero-Atlantic World



Amsterdam
University
Press

Maritime Humanities, 1400-1800: Cultures of the Sea

Early modern oceans not only provided temperate climates, resources, and opportunities for commercial exchange, they also played a central role in cultural life. Increased exploration, travel, and trade, marked this period of history, and early modern seascapes were cultural spaces and contact zones, where connections and circulations occurred outside established centres of control and the dictates of individual national histories. Likewise, coastlines, rivers, and ports were all key sites for commercial and cultural exchange. Interdisciplinary in its approach, *Maritime Humanities, 1400–1800: Cultures of the Sea* publishes books that conceptually engage with issues of globalization, post-colonialism, eco-criticism, environmentalism, and the histories of science and technology. The series puts maritime humanities at the centre of a transnational historiographical scholarship that seeks to transform traditional land-based histories of states and nations by focusing on the cultural meanings of the early modern ocean.

Series Editors: Claire Jowitt and John McAleer

Advisory Board Members: Mary Fuller, Fred Hocker, Steven Mentz, Sebastian Sobecki, David J. Starkey, and Philip Stern



Amsterdam
University
Press

Exploration, Religion, and Empire in the Sixteenth-century Ibero-Atlantic World

A New Perspective on the History of Modern Science

Mauricio Nieto Olarte

Amsterdam University Press



Amsterdam
University
Press

Originally published as: *Las máquinas del imperio y el reino de Dios. Reflexiones sobre ciencia, tecnología y religión en el Atlántico del siglo XVI*, Ediciones Uniandes 2013

Translation: Jimmy Weiskopf

Cover illustration: Frans Huys (engraver) and Pieter Brueghel the Elder (designer), *Armed three-masted ship off a coast, with the Fall of Daedalus and Icarus*, c. 1561–1562. Engraving and etching; three states known. CC BY-NC © Fondation Custodia, Collection Frits Lugt, Paris

Cover design: Coördesign, Leiden

Lay-out: Crius Group, Hulshout

ISBN 978 94 6372 531 6

e-ISBN 978 90 4854 454 7

DOI 10.5117/9789463725316

NUR 685

© M. Nieto Olarte / Amsterdam University Press B.V., Amsterdam 2022

All rights reserved. Without limiting the rights under copyright reserved above, no part of this book may be reproduced, stored in or introduced into a retrieval system, or transmitted, in any form or by any means (electronic, mechanical, photocopying, recording or otherwise) without the written permission of both the copyright owner and the author of the book.

Every effort has been made to obtain permission to use all copyrighted illustrations reproduced in this book. Nonetheless, whosoever believes to have rights to this material is advised to contact the publisher.



Amsterdam
University
Press

*'Muchos viajarán y el conocimiento aumentará'*¹

*'[...] España descubrió el Nuevo Mundo para que todas las naciones
estuvieran bajo una sola ley'*²

1 *Multi pertransibunt & augebitur scientia* ('Many shall run to and for, and knowledge shall be increased'). Prophecy from the Book of Daniel 12:4, on the frontispiece of Francis Bacon's *Instauratio Magna*, first published in London in 1620.

2 Campanella, Tommaso, ('Spain discovered the New World so that all nations would be under a single law') 'La Imaginaria ciudad del sol, idea de una República Filosófica', in: Ímaz Eugenio, *Utopías del Renacimiento*, 17th ed., Fondo de Cultura Económica, Mexico, 2009, page 30.



Emma, your life resembles that of the protagonists of this book: it has been full of questions, discoveries, adventures, and new horizons. Like the explorers of the Atlantic, you do not like limits: you are independent and stubborn, and I hope that you will be like that forever.



Amsterdam
University
Press

Table of Contents

List of illustrations	11
Acknowledgments	15
Introduction	17
The New World and the problem of Eurocentrism	17
Science and empire	27
Summary of the chapters in this book	32
1. The Iberian Peninsula and the Atlantic	37
Portugal and Spain	37
Winds, currents, and sailing ships in the Atlantic	44
Gold, silver, slaves, souls, and a thousand kinds of trees	50
2. The imperial bureaucracy and the appropriation of the New World	55
Seville and the <i>Casa de Contratación</i>	58
The universal monarchy	64
3. The <i>piloto mayor</i>: cosmography and the art of navigation	75
The post of <i>piloto mayor</i> : seamanship and cartography	76
The navigation manuals	80
Manuals for the Empire	81
Publications, dissemination, and secrecy	89
Humanism and the classics	92
Experience and authority	105
Man against the sea: shipwrecks and meteorology	109
Routes and chorographic descriptions: The New World within the new global order	116
4. Machines of the empire	119
The ships	125
Shipbuilding	132
War and artillery	141
Navigational instruments	143
The astrolabe	145
The cross-staff	151
The mariner's compass	158

Time and clocks	166
The sounding/plumb line	172
The navigation charts	172
Astronomical tables	175
Instruments, measurements, precision, and standardization	182
The crew	185
The captain/admiral	191
The pilot	191
The shipmaster (<i>maestre</i>) and quartermaster (<i>contramaestre</i>)	195
The boatswain (<i>guardián</i>)	195
The ordinary seamen (<i>marineros</i>)	196
Midshipmen (<i>grumetes</i>) and cabin boys (<i>pajes</i>)	196
The carpenter, steward, cooper, and cook	197
The scribe, master-at-arms, and overseer	198
The cannoneer	198
The barber/surgeon	199
The priest	199
Life on board	199
The argot of the sailors	200
Overcrowding	202
Food and health	204
Men of the sea and men of God	207
5. The Master Map (<i>Padrón Real</i>) and the cartography of the New World	217
Nautical charts and how they were made	223
The making of a chart	225
The charts of <i>tierra firme</i> : the earliest maps of the New World	229
Three early maps of the New World	234
Juan de la Cosa (1500)	234
Waldseemüller (1507)	236
Diego Ribero (1520)	240
6. The creatures of God never seen before: natural history	245
Nature in the New World	245
The classics and the Bible	252
Monsters in paradise	258
To describe, classify, and name	263
Medicine, botany, and the knowledge of the natives	271
The Empire and natural history	281



7. The New World, global science, and Eurocentrism	285
<i>Plus ultra</i>	285
Experience and authority	292
The Empire and the challenge of standardization	300
Eurocentrism	303
Bibliography	307
About the Author	319
Index	321





Amsterdam
University
Press

List of illustrations

<i>Illustration 1.1.</i>	On the winds, their quality and names, and how one should sail in them	47
<i>Illustration 1.2.</i>	The planetary winds	48
<i>Illustration 1.3.</i>	The main ocean currents on the Earth	48
<i>Illustration 1.4.</i>	The voyages of Columbus, 1492–1503	49
<i>Illustration 2.1.</i>	Panoramic view of Seville in the 17 th century	60
<i>Illustration 3.1.</i>	<i>Suma de Geographia</i> , by Martín Fernández de Enciso	83
<i>Illustration 3.2.</i>	<i>Regimiento de Navegación</i> , by Pedro de Medina	84
<i>Illustration 3.3.</i>	Cartagena and Punta de los Icacos	93
<i>Illustration 3.4.</i>	<i>Arte de Navegar</i> , by Pedro de Medina	96
<i>Illustration 3.5.</i>	The sphere and the four elements	97
<i>Illustration 3.6.</i>	Ptolemaic map	99
<i>Illustration 3.7.</i>	The four elements: earth, water, air and fire	100
<i>Illustration 3.8.</i>	The celestial sphere, with the Earth in the center, around which the Sun, planets, and stars revolve	101
<i>Illustration 3.9.</i>	Poles of the world and the basic coordinates of the heavenly sphere	102
<i>Illustration 3.10.</i>	Height of the Sun above the equinoctial line	103
<i>Illustration 3.11.</i>	The seven planets	104
<i>Illustration 3.12.</i>	Rules of the tides	111
<i>Illustration 3.13.</i>	Navigational instructions XIII: ‘On when the ship is grasped by the force of the weather and is in danger of being lost: what one should do to correct it’	112
<i>Illustration 3.14.</i>	Navigational instructions XI: ‘On the measures [remedy] which should be taken when the vessel is sailing and ships a lot of water’	114
<i>Illustration 4.1.</i>	<i>Columbus the first discoverer</i> , by Theodor de Bry	122
<i>Illustration 4.2.</i>	Navigational instructions II: ‘How the pilot should know the ship in which he has to sail and be familiar with the peculiarities it has’	126
<i>Illustration 4.3.</i>	Displays of a ship that sails against the wind and into the wind	128
<i>Illustration 4.4.</i>	<i>Sailing ship with the Fall of Icarus</i> , by Peter Brueghel	132



<i>Illustration 4.5.</i>	'On the calculations and other things which pertain to the measurements of the Hull of any Ship'	138
<i>Illustration 4.6.</i>	'On the calculations and other things which pertain to the measurements of the Hull of any Ship'	138
<i>Illustration 4.7.</i>	On the mainsail and foresail	140
<i>Illustration 4.8.</i>	Maritime astrolabe	147
<i>Illustration 4.9.</i>	Explanation of the position the sailor must follow when he is sailing on the sea and wishes to know the height of the Sun	150
<i>Illustration 4.10.</i>	Nautical astrolabe	152
<i>Illustration 4.11.</i>	Explanation of the astrolabe for taking the height of the Sun and its use	153
<i>Illustration 4.12.</i>	Explanation of the quadrant for taking the height of the Sun and the stars, and its use	154
<i>Illustration 4.13.</i>	Drawing of the use of the astronomical staff or cross-staff	155
<i>Illustration 4.14.</i>	On the height of the north	156
<i>Illustration 4.15.</i>	Use of the cross-staff	157
<i>Illustration 4.16.</i>	Order and rule of the Southern Cross in order to take its height, both on sea and on land	159
<i>Illustration 4.17.</i>	Explanation of the mariner's compass	160
<i>Illustration 4.18.</i>	Compass needle	161
<i>Illustration 4.19.</i>	Compass rose	162
<i>Illustration 4.20.</i>	<i>Carta Pisana</i> , c. 1275	163
<i>Illustration 4.21.</i>	On the mariner's compasses	165
<i>Illustration 4.22.</i>	Sixteenth-century mariner's sandglass	169
<i>Illustration 4.23.</i>	Night chart to determine the hours with the North Star	170
<i>Illustration 4.24.</i>	On sailing in the western seas and lands	171
<i>Illustration 4.25.</i>	Table of the Sun's declination	176
<i>Illustration 4.26.</i>	On the height of the Sun and the rules for navigating by it	179
<i>Illustration 4.27.</i>	Perpetual table to find out lunar conjunctions	181
<i>Illustration 4.28.</i>	Phases of the Moon	182
<i>Illustration 4.29.</i>	Tables to find out at what hours the tides come in	183
<i>Illustration 4.30.</i>	Calendar	214
<i>Illustration 5.1.</i>	Map of the recently discovered New World	220
<i>Illustration 5.2.</i>	Map of the New World	221

<i>Illustration 5.3.</i>	Maps of different parts of America	222
<i>Illustration 5.4.</i>	Navigational chart containing the navigation for most of Europe, Africa, the Indies or New World, and the altitude and degrees that each thing has	225
<i>Illustration 5.5.</i>	The leagues calculated by degree in each course of the voyage	233
<i>Illustration 5.6.</i>	Juan de la Cosa's Map, 1500	235
<i>Illustration 5.7.</i>	Compass rose with a picture of the Virgin Mary and Jesus at the center of the map	236
<i>Illustration 5.8.</i>	In the middle of the New World the figure of Saint Christopher crosses the seas, suggesting the idea of a passage to the Orient	237
<i>Illustration 5.9.</i>	<i>Universalis Cosmographie descriptio in plano</i> , by Martin Waldseemüller	238
<i>Illustration 5.10.</i>	Universal map containing all of the world that has been discovered up to now, by Diego Ribero	241
<i>Illustration 5.11.</i>	Quadrant	242
<i>Illustration 5.12.</i>	Toponymy of the New World	243
<i>Illustration 6.1.</i>	Iguana	259
<i>Illustration 6.2.</i>	Pineapple	267
<i>Illustration 6.3.</i>	<i>Tlazolteozacatl, Tlayapaloni, Axocotl, Chicomacatl</i>	276
<i>Illustration 6.4.</i>	<i>Tezonpahtli, Huitzquilitl, Tecuammaitl</i>	278
<i>Illustration 6.5.</i>	<i>Atzitzicaztli</i>	279
<i>Illustration 6.6.</i>	Museum of Ferrante Imperato in Naples, 1599	283
<i>Illustration 7.1.</i>	Frontispiece of Francis Bacon's <i>Instauratio Magna</i>	287
<i>Illustration 7.2.</i>	<i>Historia general y natural de las Indias</i> , by Gonzalo Fernández de Oviedo, 1535.	290
<i>Illustration 7.3.</i>	<i>Regimiento de Navegación</i> , by Andrés García de Céspedes, Folio I.	291



Amsterdam
University
Press

Acknowledgments

I must clarify that the contents of this book and its proposals of a theoretical nature are obviously indebted to specific books and authors. My aim here is not to present an exhaustive account of the state of art in this field but to acknowledge those studies that motivated and shaped the questions and arguments in this book. For example, John Law's works on Portuguese navigation have been an obvious inspiration for the general framework of this investigation.

There is a long list of authors who have dealt with the sixteenth-century Iberian science and I hope that I have given them their due credit in the footnotes of this book. However, I must single out the pioneering studies of José María López Piñero, as well as the more recent editorial emendation of Antonio Barrera, Jorge Cañizares, María Portuondo, and Alison Sandman, who have conclusively shown that there is an urgent need to study these aspects of the history of European modernity.

This book would not have been written without the support of the Universidad de los Andes. The first stage of the project was aided by the Centro de Estudios Sociales (Center of Social Studies – CESO) of the School of Social Sciences. Subsequently, the second stage was financed by Colciencias (the Administrative Department of Science, Technology and Innovation, a Colombian government agency that supports fundamental and applied research); Lastly the final writing of the book would not have been possible without the collaboration of the History Department of Social Science of the University de los Andes, which granted me a sabbatical in the first semester of 2011.

Throughout the whole process of researching and writing this book, I had the support of graduate students. The help of Rafael Acevedo was a decisive factor in the initial stages of research and the assembling and organization of information. When it came to editing the manuscript, the help of Daniela Samur was equally crucial, as she put the chaos of quotes and references of the first draft into order. In addition, Lina Rocío Medina undertook a general revision of the text. The contributions and suggestions of all these people were very opportune. The comments made by Camilo Quintero and Alexis De Greiff after reading the manuscript helped me to spot flaws, which I have tried to correct.





Amsterdam
University
Press

Introduction

Abstract

The book's introduction exposes its historiographical challenges and theoretical framework. This includes a discussion of the limitations of the traditional forms of considering the relationship between science and empire, and proposes original ways of dealing with old problems related to both Eurocentrism and modern science.

Key words: Discovery, Modern Science, Voyages of exploration, Eurocentrism

The New World and the problem of Eurocentrism

'The greatest thing after the creation of the world, except for the incarnation and the death of he who gave birth to it, is the discovery of the Indies'.¹ Francisco López de Gómara wrote those words in the Introduction to his *Historia General de las Indias* (General History of the Indies), published in 1552. Far from being an extravagant idea at the time, the providential notion that God wanted Spain to conquer the New World for the spread and final triumph of Christianity² was widely shared by the chroniclers and cosmographers of the Spanish Crown in the 16th century.³ As the Spaniards saw it, 1492 was the year that split the history of the world in two; five centuries later, we are still trying to understand what happened and the world has not finished adjusting itself to the changes that began in the Atlantic.

1 López de Gómara, Francisco, *Historia General de las Indias*, [1552], Pilar Guibelalde and Emiliano Aguilera (eds.), Barcelona, Iberia, 1965, 'To Don Carlos, Emperor of the Romans, King of Spain, Lord of the Indies and the New World', page 5.

2 Ibid., 'God wished the Indies to be discovered in your age and by your vassals, so that they would be converted to his holy law, as many wise and Christian men say', page 6.

3 López Piñero, José María, *El arte de navegar en la España del Renacimiento*, Barcelona, Editorial Labor, 1986, Chapter VIII.

In the abovementioned introduction to his book, López de Gómara wrote that ‘every history, even if is not well written, delights’,⁴ this may be a questionable statement but it is a convenient way to raise your spirits when you set out to write an incredible history of the European Renaissance. Here, is yet another attempt. This time, the account will deal with personages and regions which are little seen in the historiography of modern science: the Iberian Catholics in the Atlantic world.

Many have called the 16th century the century of discoveries. Equating European expansion with the ‘age of discoveries’ forms part of a view of history that is centered on Europe and that is only possible when the great explorers who preceded Columbus are forgotten. One might mention, for example, the Polynesians’ maritime explorations of the Pacific, the Nordic navigators in the Atlantic, and, naturally, the Chinese who, led by admiral Zheng, crossed the Indian Ocean.⁵ However, it is undeniable that at the end of the 15th century and throughout the 16th century the Christian navigators, and the Iberians in particular, opened routes, sailed long distances, and entered into contact with parts of the globe and cultures that were then completely unknown. This is not the place to write a full account of the maritime expansion of Europe in the 16th century, but it is nevertheless worth recalling some names in order to form an idea of the scale of the endeavor of Christian expansion in that period. Admiral Christopher Columbus sought an alternative trade route to the Orient and managed to cross the Atlantic four times; and, while he never reached Cipango, he found a continent that was new to Europeans along the way. Vasco de Gama reached India from Lisbon and returned to the Portuguese capital after slightly more than two years circumnavigating the continent of Africa: a voyage in which less than half of his men survived. After a voyage of more than 40 days, Pedro Álvares Cabral reached the coasts of Brazil, while Amerigo Vespucci, Juan de la Cosa and Alonso de Ojeda, among others, explored a large part of the eastern coast of America. Ferdinand Magellan, following Columbus’ idea of finding a passage to the east by sailing west, set out on an expedition that circled the world. In August 1519, Magellan departed from Seville with 234 men on board and five ships: after a voyage of slightly more than two years, only eighteen survivors returned in a single ship commanded by Juan Sebastián Elcano. Basque navigators and cosmographers such as Andrés Urdaneta and Miguel López de Legaspi conquered the Pacific and

4 López de Gómara, Francisco. *Historia General de las Indias*, op. cit, ‘To the readers’, page 3.

5 See: Fernández-Armesto, Felipe, *Pathfinders: A Global History of Exploration*, New York, W. W. Norton, 2006.



took possession of the Philippine islands. All of this happened in just a few decades and, for the first time in the history of the world, one people—the Christian monarchies—thought it would be possible to conquer the whole world. *Plus Ultra* was their motto and Christian monarchs were regarded as universal rulers.

It would be difficult to determine the precise moment at which what is known as the ‘process of globalization’ began, nor is there is a birthdate for things such as world trade or universal science, but there is no doubt that the 16th century witnessed unprecedented changes on a global scale. The Iberian exploration of the Atlantic in the first half of the 16th century consolidated two enormous commercial axes and two great monopolies: that which was forged between Portugal and India, specifically, between Lisbon and Goa, and that which was forged between Spain and America, which linked Seville with different ports in the Caribbean and the Gulf of Mexico.⁶ These axes were the main commercial networks of Europe outside of the Mediterranean and also the foundation upon which the new world order was built, when Christian Europe proclaimed its hegemony over a large part of the planet. A number of similarities can be seen between the two empires: among them, their Iberian and Catholic origin in the context of a fierce ‘holy war’ against any non-Christian nation and the urgent need to establish more efficient trade routes beyond the circuits of the Mediterranean. However, there are also important differences. The Spanish vessels that sailed toward the Indies carried passengers, casks of wine, barrels of flour, pitchers of oil, tools, agricultural implements, seeds, domestic animals, and, of course, a powerful armaments. By contrast, the Portuguese vessels, which were also strongly armed and fitted out, sailed to the east loaded with ballast and passengers who would work in their trading posts (*factorías*).⁷ On the return voyage, their cargoes were also different, since the ships from India arrived in Europe with spices—pepper, cloves, cinnamon, and nutmeg—and manufactured goods such as silks, porcelains, and other oriental works of art, comparatively the most valuable cargoes brought back by the Spanish ships were gold and silver. The East Indies and West Indies —as sixteenth-century Europeans referred to those parts of the world— were two different worlds at that time and therefore, established singular commercial and political relations with the Christian empires.

6 Braudel, Fernand, *El Mediterráneo y el mundo mediterráneo en la época de Felipe II*, 4th ed., Mexico, Fondo de Cultura Económica, 1997, page 399.

7 Martínez, José Luis, Pasajeros de Indias. *Viajes transatlánticos en el siglo XVI*, Mexico, Fondo de Cultura Económica, 1999, page 155.

Nevertheless, despite these differences, both the Spaniards and Portuguese had to face the same challenge: long-distance control. The conquest of remote places, the control of trade or the establishment of an imperial system is, in the end, a problem of communication: to proclaim their rule, they needed a safe means for the circulation of information, goods and people.

The objects and products that this book deals with are not traditional merchandises: they do not take up space nor are they very heavy cargoes. For the most part, they are printed products, visual records, chronicles, maps, texts, and collections of data that constantly circulated between the New and the Old World. The focus of study in this investigation is the knowledge of those techno-scientific practices, which, as they interacted with other political, religious and geographical factors, enabled Christian Europe to dream of controlling the whole of the Earth.

From the earliest chroniclers of the 16th century to today, the idea of 'discovery' has been a dominant concept in the historiography of the modern world, a key notion in our Eurocentric conception of history and one that is central to the exalted idea of progress in the West. 'To discover' implies an individual feat or achievement in which someone, at a specific time, sees or encounters something that no one had seen before; it also implies that the discovered object existed as such, in itself, before and independently of its discoverer. 'Discoveries' have also been presented as forms of appropriation in which, in a more or less natural way, the discoverers proclaim their right to possess and rule over the discovered places and objects, so that the narratives of 'discoveries' are celebrations of the European's power over nature, commemorative acts that have helped to idealize the scientific practices through which Western culture proclaims its control and power over the world. The idea of discovery has also been key in the creation of the idea of modern science, which, in turn, has been definitive for the notion of Western Europe as the center and driving force of history. Thus, it is often assumed that the history of modern science and, by extension, the success of the expansion of the European world and man's conquest of nature can be reduced to a series of crucial 'discoveries' and individual feats. In the field of geographical exploration, specific remarks, such as 'Christopher Columbus discovered America in October, 1492' or 'Vasco Núñez de Balboa discovered the Pacific Ocean', are common and generally accepted, but the narratives of the discovery of universal laws, principles, or truths⁸ are also frequent and applauded.

8 For a critical look at the idea of discovery, see: Brannigan, Augustine, *The Social Basis of Scientific Discoveries*, Cambridge, Cambridge University Press, 1981.



Philosophical subtleties are not needed to acknowledge the absurdity of statements such as ‘Christopher Columbus discovered America on October 12, 1492’. The ‘discovery’ of America was not a unique event, restricted to the voyages of Christopher Columbus at the end of the 15th century. Instead, it should be understood as process that stretches from before 1492 to, if you like, our time. We are speaking of an inhabited continent and, therefore, one known by human beings and probably visited by Europeans and Asians before Columbus. More important still, the statement is meaningless and turns out to be anachronistic since neither in 1492, nor in the moment when he died after four transatlantic voyages, did something like our idea of an American continent exist in Columbus’ mind. The statement only became possible and acquired meaning after the cartographers, politicians, kings, popes, chroniclers, and political elites acknowledged and agreed on the new borders, characteristics, and reality of the New World. Likewise, this notion of discovery presupposes a one-directional and asymmetric process in which America and its native population are reduced to an object whose reality depends on the feats of Europeans.

Other concepts have been used to explain the appearance of America in world history. As an alternative to this one-directional perception of the discovery of America, and in the hope of offering a symmetrical view in which the voices of both Europeans and the natives of America are acknowledged, some have preferred to speak of an ‘encounter’ of the two worlds. It is an attractive idea and a subject of growing interest for cultural history. As Peter Burke points out, there are no genuinely pure and isolated cultures, and cultural frontiers are always diffuse and mobile.⁹ In particular, the history of the empires of the Iberian Atlantic is the history of encounters and cultural interaction, and the idea of hybrid or *mestizo* cultures is a reality in the history of the Atlantic world. Recent historiographical debates try to fight against the isolation of national or regional histories and increasingly defend the notion of ‘connected histories’, histories of the Atlantic world, or histories of the world as a whole.¹⁰

However, the idea of an ‘encounter’ implies the possibility of a symmetrical narration in which the different cultures that are involved in the phenomenon are comparable in a balanced manner. There have numerous

9 Burke, Peter, *Formas de Historia Cultural*, 2nd ed., Madrid, Alianza, 2006.

10 For the particular subject that is dealt with in this book, see: Cañizares-Esguerra, Jorge and Seeman, Erik R., *The Atlantic in Global History, 1500–2000*, Upper Saddle River, NJ, Pearson Prentice Hall, 2007; or Delbourgo, James and Dew, Nicholas (eds.) *Science and Empire in the Atlantic World*, Routledge, London, 2008.

efforts by anthropologists and historians to reconstruct the viewpoint of the ‘other’ or the ‘voice of the defeated’ in order to make us see, for example, the way in which the Caribs thought of Columbus, the Aztecs to the armies of Cortés, or the Incas of Pizarro, and one of the greatest challenges for the social sciences has been to explain strange cosmologies and other forms of knowledge. This longed-for symmetry presents serious methodological and historiographical difficulties since, in most cases, the native voices and points of views, can only be reconstructed through the narrations or interpretations—or, alternatively, deconstructions—found in the European narratives. These well-intentioned efforts to make the ‘subaltern’ visible are often marred by ingenuousness or new ways of concealing the other that one wishes to speak for. From the sixteenth-century chroniclers to the ethnography of the 21st century, the modern or postmodern historian or ethnographer’s pretense to be the legitimate spokesmen for the native inhabitants of American continent is full of insuperable difficulties.¹¹ Along that line of thought, it is important to stress that this book seeks to explore possible paths for a better understanding of European rule and thus it is not interested in either celebrating or denying Eurocentrism. In any case, the historical consequences of the process that this book wishes to investigate are far from balanced and the purpose of this investigation is to contribute possible explanations of a world order with an obvious asymmetry, the center of which was Christian Europe.

Such attempts to be neutral and symmetrical may not seem very realistic and for some it would be more correct to try for a narrative which unambiguously denounces the horror of the conquest. From Fray Bartolomé de las Casas to some twenty-first-century historians, the objective of historical narrative has been to show the brutality of the European conquest of America. Many have preferred terms like the ‘European invasion’¹² to denounce the violent character of the European’s entrance into the American continent and abandon any hint of a heroic celebration of the conquest. Tzvetan Todorov baldly denounces the conquest of America as ‘the biggest genocide

11 On the difficulties of writing a non-Eurocentric history and the problem of acknowledging the voices which some call ‘subaltern’, see, for example: Spivak, Gayatri Chakravorty, ‘Can the Subaltern Speak?’, in: Nelson, Cary and Grossberg, Larry (eds.), *Marxism and the Interpretation of Culture*, Chicago, University of Illinois Press, 1988, pages 271–313; and Dirlik, Arif, ‘History without a center? Reflections on Eurocentrism’, in: Fuchs, Eckhardt and Stuchtey, Benedikt (eds.), *Across Cultural Borders: Historiography in Global Perspective*, Boston, Lanham, Rowman and Littlefield, 2002, pages 247–284

12 Carmagnani, Marcello, *El otro occidente. América Latina desde la invasión europea hasta la globalización*, Jaime Riera Rehren (trans.), Mexico, Fondo de Cultura Económica, 2004, page 35.

in human history' and has no problem in accepting and defending, with sound reasons, his preference for a moralist history instead of a neutral one.¹³ There is abundant evidence to justify such a denouncement, but a simple accusation does not seem to be sufficient. A one-sided description of a crime may be a lesson for the future and is also necessary for a healthy reconstruction of the memory of the native peoples of America and the history of their conquerors, but it fails to explain the 'success' of Christian Europe and teaches us little about the cultural practices that made European sovereignty possible, both in America and in a large part of the world.

Other authors have preferred to speak of the 'social construction' or 'invention' of America.¹⁴ This kind of analysis allows one to overcome some of the deficiencies of the traditional view of the discovery of ahistorical objects, but leads to another problem: reducing the reality of America to a mere 'social construction' and a European creation, where there is little room to interpret the role of geography, nature, and the peoples of America in the history of the Atlantic world. As will be shown below, the natural setting, population, and geography of the New World form an active and definitive part of that history. In addition, the concepts of 'invention' and 'construction' do not offer an alternative to the traditional dichotomies between Europe and the 'others', between culture and nature and between subject—the European subject in this case—and object, the American one. While such dichotomies are fundamental for our modern notion of science, they cannot be the starting point for historical analysis. The same dichotomies need to be historically explained. We are dealing with a lengthy process of change, during which the New World was incorporated into European culture at the same time in which Europe transformed and rebuilt its own identity.

In the face of this complex panorama it will be argued that the idea of 'comprehension' may be useful, not simply as an alternative that replaces all previous ideas, but also as a concept that may have advantages and that might help us to understand the conquest of the New World from an epistemological point of view in which scientific practices play an essential role. Both in the conquest and domestication of the new and in the construction of a new subject with pretensions to global rule, science was a central actor.

13 Todorov, Tzvetan, *La conquista de América. El problema del Otro*, Flora Botton Burlá (trans.), Mexico, Siglo XXI, 1989, page 14.

14 See, for example: O'Gorman, Edmundo, *La invención de América*, Mexico, Fondo de Cultura Económica, 1995; and Rabasa, José, *Inventing America: Spanish Historiography and the Formation of Eurocentrism*, Norman, University of Oklahoma Press, 1993.

According to the dictionary of the Royal Academy of the Spanish Language, the root of ‘to comprehend’ is the Latin verb *comprehendere*, from meaning *cum*, ‘with’, and meaning *prehendere*, ‘to take hold of’. This original meaning of the term is key to understanding the practices associated with the discovery and conquest of the New World—cartography, natural history, or moral history—as powerful ways of declaring the right to own and rule over nature and people. Thus, to comprehend implies an act of appropriation, a process of translating the unknown into something familiar, of incorporation and domestication, as well as a recognition of the alien. Nevertheless, this first definition is insufficient and maintains the one-directional sense in which Europe is the *subject* and America the *object* of that understanding, and once more seems to lead to the limited perception of a passive New World that is appropriated by Europe. We should make it clear that when one refers to the ‘understanding of the New World’, a reflective act is implicit that cannot be limited to the apprehension or comprehension of something that is external but is, rather, one in which both the *subject* that comprehends and the *objects* of that comprehension¹⁵ actively participate and are transformed. It is a process in which the agents and objects of the appropriation are constructed at the same time. From this point of view, 1492 is a date that should recall the ‘discovery’ or ‘construction’ of both America and Europe.

As José Rabasa has suggested, this means that the term ‘New World’ should not be limited to that geographical space, one that is different from Europe,

15 To answer this question, it might be useful to go back to some ideas found in hermeneutic philosophy. The problem of comprehension has been the subject of important philosophical studies in the 20th century, some of which are worth having a brief look at. For the argument we wish to develop, it is interesting to recall the existential meaning that Martin Heidegger gives to the idea of ‘comprehension’. To comprehend is not the act of knowing or possessing something that lies ‘before one’s eyes’, but it is a constitutive act of ‘being there’. For Heidegger, to comprehend has the sense of a projection in which ‘being in the world’ arises. To understand is always a form of self-understanding, since understanding is only possible to the extent that one acknowledges the coexistence of the person who comprehends and others and the world. The ideas H.G. Gadamer draws from hermeneutic philosophy are also relevant, as when he states that ‘insofar as it is a hermeneutic task, comprehending always includes a reflective dimension. At bottom, comprehending is always comprehending oneself, but not in the manner of a previous self-possessing or one that is already attained. Because this self-understanding is realized in the understanding of something’. Hence, it is through the strange or alien that human beings come close to themselves. The motive or the incitement of such understanding is alterity: it begins when something strikes one’s attention and it thus implies movement, a coming and going between the strange and the familiar. Heidegger, Martin, *El ser y el tiempo*, Jose Gaos (trans.) Mexico, Fondo de Cultura Económica, 1983, page 163; Gadamer, Hans-Georg, *Verdad y Método. Fundamentos de una hermenéutica filosófica*, Salamanca, Sígueme, 1992, page 121.

that was the object of European exploration and exploitation from the 16th century onwards¹⁶ but should instead refer to the conception of the world that arose from the European conquest of a large part of the terrestrial globe. The construction or invention of the New World is thus inseparable from the invention of Europe. Hence, the voyages of exploration and the zeal to create catalogues and inventories of nature; the creation of maps and bodies of knowledge about geography, seamanship, and cosmography; the establishment of a colonial trade and administration; the improvement of mining techniques; and the study of medical, botanical, zoological, ethnographical and climatic matters, or the customs and history of other cultures, were all fundamental practices in the consolidation of a new world in which Christian Europeans gradually emerged as spokesmen for the rest. It is not only the representation or the construction of America that can be recognized in these scientific practices: it is at the same time, the construction of the Old World. That new *order* that comprehends and creates links between the familiar and the new was conceived in a culture that defined itself by its determination to domesticate the New World, as well as its ambition to rescue the rest of the world from barbarism and paganism.

Studying the 16th century means that you have to face big historiographical problems, both in political history and in the field of the history of science and technology. The aim of this book is to contribute to the historical comprehension of a notable change in the balance of world powers. How did the building of big European empires in the 16th century become possible? What actions and practices made it possible for them to proclaim their control over a world separated by enormous distances of land and sea? A definitive answer to such broad and complex questions is beyond the scope of this study; instead, its aim is to explore paths and link different fields of investigation such as political history and the history of science and technology.

In his book *Empires of the Atlantic World*, John H. Eliot suggests that Europe's domination of America must be explained on three different and complementary levels: the symbolic taking of possession, the material occupation, and the settling or resettling of lands.¹⁷ There is no doubt that these are crucial aspects for understanding the conquest of America, but, like most of the analyses of imperial history, this approach ignores the

16 Rabasa, José, 'Inventing America: Spanish Historiography [...]', op. cit. While Rabasa deals with the 16th and 17th centuries, this idea still holds for the period covered by this book.

17 Elliot, John Huxtable. *Empires of the Atlantic World: Britain and Spain in America, 1492–1830*, New Haven/London, Yale University Press, 2006, page 64.

epistemological shift that made the appropriation of the alien possible and neglects the importance of an intense scientific activity that made it possible for the cultural centers of Europe to act on and control the New World from a distance. To attain a better understanding of the history of the Iberian world in the Atlantic, we need a careful study of the techno-scientific practices that allowed for both the European appropriation of the New World and the building of a new world order.¹⁸ In the course of this book we will show how the grand Iberian empires of the 16th century were a great techno-scientific endeavor and how this relation between science and empire has important consequences for the history of science in the West.

The use of the term 'Eurocentrism' may be problematical if it is taken to mean that Europe is a discrete and homogenous actor, since it is obvious that Europe, as it is usually understood, shows a notable cultural diversity and has geographical, cultural, and economic centers and peripheries. However, the point is precisely to learn about the great Christian endeavor of conquering the whole world. As Tomaso Campanella said: 'thus Spain discovered the New World so that all nations would be under a single law'.¹⁹ This investigation is therefore oriented toward a better understanding of the process of constructing the idea of a homogenous Europe or the consolidation of the West as a geographical and cultural entity, which is only possible insofar as one confronts something that is different and creates the referent of an 'other' that is common to the whole Christian world. Hence, it is a process that is clearly related to the exploration of the rest of the world and means that, despite their enormous differences, even within their own nations, Portugal, Spain, and Italy, —and, later, England, France, Holland, and Germany—, can be seen as a community with collective interests and familiar traits that were emphasized as the New World was gradually conquered.

Both 'the West' and 'Europe' are categories that should be historically explained.²⁰ An interesting standpoint on this problem is the one set forth by Arif Dirlik, who says that the true power of a Eurocentric view does not lie in the exclusion of 'the others' but, on the contrary, their inclusion: in the

18 On the role of technology in modern imperial history, see: Cipolla, Carlo M., *Las máquinas del tiempo y de la guerra. Estudios sobre la génesis del capitalismo*, Barcelona, Crítica, 1999; or Chaunu, Pierre, *European Expansion in the Later Middle Ages*, Oxford, North Holland Pub. Co., 1979.

19 Campanella, Tommaso, 'La imaginaria ciudad del sol [...]', op. cit., page 30.

20 On this aspect, see: Dussel, Enrique, 'Europa, modernidad y eurocentrismo', in: Lander, Edgardo (comp.), *La colonialidad del saber. Eurocentrismo y ciencias sociales. Perspectivas latinoamericanas*, Buenos Aires, Clacso, 2000, pages 41–53.

inscription of the whole world in a single order and system.²¹ This idea of ‘comprehension’ as a process of inclusion and therefore of self-understanding will be central in this book. The ‘scientific’ practices discussed herein may be understood as forms of inclusion, processes through which links are created and the alien is changed into the familiar. It is in that sense that the idea of the ‘comprehension of the New World’ enables us to attain a better understanding of the science and political history of the Iberian Atlantic.

The Christian Europe of the Renaissance succeeded in incorporating the unknown into its own familiar frameworks and thus it proclaimed its dominion over strange seas, islands, continents, peoples, animals, and plants. In order to answer the question of how this became possible it will be useful to make use of some theoretical proposals found in current social studies of science.

Science and empire

Whatever their object of study may be it seems that historians are forced to take sides on the nature of historical causes and superpose one cause on, or subordinate it to, others. Some opt for economic, political, ideological, or religious explanations, while others have sought to make technology itself the explanation of history. In the introduction to his book on technology and empire, *The Tools of Empire*, Daniel R. Headrick faces the question of whether it is imperialism that shapes technology or, on the contrary, technology that shapes empires.²² Before addressing this problem, Headrick reminds us of the limitation that one of the central axioms of modern historiography entails: the explanation of the past as the result of the interaction of human decisions,²³ or, what is the same thing, the search for causes that, in one way or another, might be called social causes.²⁴ Such causes of a ‘social’ nature

21 Dirlik, Arif, ‘History without a center? [...]’, op. cit., page 252.

22 Headrick, Daniel R., *The Tools of Empire: Technology and European Imperialism in the Nineteenth Century*, Oxford, Oxford University Press, 1981, page 4. These questions take us back to an old debate between historians of science about the validity of an ‘externalist’ or ‘internalist’ historiography of science. See, for example: Shapin, Steven, ‘Discipline and Bounding: The History and Sociology of Science as Seen through the Externalism–Internalism Debate’. In, *History of Science*, Vol. XXX, 1992, pages 333–369.

23 Headrick, Daniel R., ‘The Tools of Empire: Technology [...]’, op. cit., page 9.

24 This problem has been discussed by authors like Lagdon Winner in his essay ‘Tienen política los artefactos?’, in: *La Ballena y el Reactor. Una búsqueda de los límites en la era de la alta tecnología*, Barcelona, Gedisa, 1987; and Latour, Bruno, *La esperanza de Pandora. Ensayos sobre la realidad de los estudios de la ciencia*, Tomás Fernández Aúz (trans.), Barcelona, Gedisa, 2001.

are generally related to political, economic, and religious interests, which are being finally understood as the result of the interests and agency of certain social groups or persons who hold and exert power over the rest. Therefore, it is not completely surprising that reality, artifacts and nature are often explained as ‘social constructions’.

Science and technology, on the other hand, may also be presented as the causes of major historical changes or as tools at the service of powerful human beings. For Carlo M. Cipolla, there is a reciprocal and complex interaction between the economy and technological developments, so that his central thesis tries to show that ‘in Europe, the nations which were the best at inventing cannons and sails attained a supremacy over the rest. The era of human energy was over, and the era of machinery began to approach’.²⁵ His main argument explains this even more clearly: ‘religion provided the pretext and gold, the motive. The technological progress which Atlantic Europe went through during the 14th and 15th centuries provided the means’.²⁶ This book does not aim to define pretexts, motives, and means, since technology should not be regarded as a resource or instrument at the service of a power that precedes it; in this case, the ‘imperial power’. On the contrary, technological practices are part of the empire and the power, not its tool. Neither will we argue that religion can be reduced to a mere pretext, since it forms part of the social order, and even less that imperial expansion can be explained as the simple result of a commercial thrust.²⁷ In the history that we set out to narrate here, we do not look for a first and unique cause, and it will become evident that artifacts, nature, the human, and the divine form part of networks and practices that afford us a better understanding of the exercise of power and the shaping of a new world order.

As though the world of the inanimate belonged to a special dimension — a dimension whose explanation would presuppose frameworks of reference different to that which is dealt with by the human— those political history rarely give artefacts the attention they deserve. Incorporating natural causes or agents into historical explanations is equally strange for the social sciences and it would be even more surprising for them to find historical causes of a divine nature. Even though the religious ambit was inseparable from the knowledge of the world of the Renaissance chroniclers and naturalists of

25 Cipolla, Carlo M., ‘Las máquinas del tiempo y [...]’, op. cit., page 145.

26 Ibid., page 179.

27 These reductions to a first cause and prime mover recall the metaphysics of Aristotle and his idea of ‘an unmoved mover’, whose movement does not need to be explained but remains the cause of all movement.



the 16th century, including explanations of a divine or spiritual nature in the analysis of history today seems unwise or absurd nowadays. As Ulrich Beck notes, '[we historians and sociologists] bear the language of secularism in our blood',²⁸ and the spiritual dimension and religious experience, which were so definitive in the Catholic world of the 16th century, are excluded from historical analyses.

To sum up, in one way or another, the social sciences have always wished to find a 'social' explanation for historical processes. Following the proposals of the Actor–Network Theory,²⁹ this study will seek to keep these apparently heterogeneous elements together—political, religious, technical, and natural factors—without letting one of these levels explain or define the role of the others. Instead, it is a matter of understanding power as the result of a conjunction of agents that are both social—human—and technical, natural, or even divine, and thus, this work will argue that the triumph of Christians in a large part of the world is explained by the mobilization and combination of these elements. The monarchs, traders, and their human interests obviously form part of history, but not because they embody a power that precedes the practices of dominion and control. In the history of the Empire, the ships, sails, cannons, winds, and current should be made visible, along with the actions of the sailors and astronomers, demons and saints, live creatures, plants, and animals.

The sailing ships of the 16th century will be the leading actors in this history although, strictly speaking, neither the ships nor sailors sailed on their own: it would be more accurate to say that the feat of crossing the Atlantic was fundamentally an achievement of the *Casa de Contratación* in Seville (House of Trade, a Crown agency with broad responsibilities for Spain's overseas interests). Only an explanation of the conjunction of the interests of the monarchy, the Christian mission to spread its dogma, the merchants of the Mediterranean, the pilots, sailors, instruments, complex ships, and all of these in alliance with the winds of the Atlantic, can offer a more complete picture of the nature of imperial power. It is therefore necessary to show the interaction and linkage among dissimilar and apparently isolated factors.

28 Beck, Ulrich, *El Dios personal. La individualización de la religión y el 'espíritu' del cosmopolitismo*, Rosa S. Carbo (trans.), Barcelona, Paidós, 2009, page 11.

29 Latour, Bruno, *Reassembling the Social: An Introduction to Actor-Network-Theory*, Oxford, Oxford University Press, 2005; Law, John, 'On Methods of Long-Distance Control: Vessels, Navigation, and the Portuguese Route to India' in: *Power, Action, and Belief: A New Sociology of Knowledge?*, London, Routledge & Kegan Paul, 1986, pages 234–263; Law, John (ed.), *A Sociology of Monsters: Essays on Power, Technology, and Domination*, London/New York, Routledge, 1991; Law, John and Hassard, John (eds.) *Actor Network Theory and After*, Oxford, Blackwell, 1999

Only in that way, through the description of complex networks, is it possible to understand how a few people proclaimed their control over enormous stretches of land, natural resources, goods, and people in remote places.

The idea of incorporating natural, geographical, or technical factors into a historical analysis is not novel, Fernand Braudel and many others have reclaimed the importance both of geography and of ships and devices in imperial history. What may be novel about the proposal of the Actor–Network Theory (ANT) lies in the fact that, according to that theory, artefacts form part of the systems of long-distance control and are not simply means or tools that serve social interests. What is possibly a particularly theoretical novelty of this investigation, even when compared with the studies of those who created the ANT, is its attempt to incorporate the agency of the divine into secular history.

The best expression of the inseparability of these social, natural, and religious factors is found in the very narratives of the 16th century itself. The chroniclers, cosmographers, and naturalists described the New World without any need to distinguish human from natural or divine aspects: a history in which it was obvious that the most powerful actor, even above the great monarchs, was the Creator, by virtue of whom all of history becomes meaningful.

The problems that this book wishes to explore have less to do with the question of when science emerged in Western Europe or who invented it than they do with identifying those practices that gave rise to a form of knowledge that enabled some to proclaim their control of the world, and to come to a better understanding of this process of expansion, the relations between the technical, economic, and the political, as well as the natural and divine need to be made visible.

Considering that the subject of this investigation is the knowledge of seamanship—the norms, regulations, and instruments produced in sixteenth-century Spain—and not so much the experience of specific explorations, it will try to show how those bodies of knowledge and practice were combined in a complex web of factors of a diverse nature. Dividing this book into separate chapters is necessary in order to present the different aspects of an intricate network of actors with a certain orderliness, but it is not meant to stress their independence of one another. On the contrary, one of the central aims of this investigation is to show their interdependence. Instead of creating links between discrete elements, it sets out to describe hybrid systems or networks in which the human, the natural, the technical, and the divine are mutually assembled and form each other. It is in those terms that the ‘machines of empire’ will be understood. As we shall see,



without a compass and magnetic needle, or without an astrolabe and sailors trained in the use of those instruments, a navigation chart would be no more than a piece of paper without any power to act on the environment. These associations are not only evident in the field of seamanship; they are also for explaining the emergence of a new natural history as something that went beyond the simple creation of the sixteenth-century naturalists. The armadillo, iguana, pineapple, and other natural wonders of the New World were not passive objects, nor were they simple 'social constructions'. In this history they should be understood as actors without whose participation the history of the New World would remain incomplete.

This introduction is not aimed at giving a 'state of the art' account of the subject: the literature on which in Spanish, English, and Portuguese is very ample, and it is obvious that this text has been built on many previous studies. The Spanish historian José María López Piñero has written about the subject³⁰ and his results are exemplary. However, he has been followed by a long list of authors, to whom I hope to give their due recognition in the course of this text.

The initial idea that gave rise to this book, which very clearly and evidently meshes with John Law's studies of fifteenth-century Portuguese voyages of discovery, was to write about ships and navigational techniques in the Atlantic in the 16th century. The wealth of primary sources on Spanish cosmography and seamanship in the 16th century—which, in general terms, are little studied by historians of science—and the growing body of literature on the role of the Catholic world in the history of modern science in Western Europe justified the idea of writing another book on science in the imperial context of the 16th century.

However, the central arguments of my book obliged me to present a broader panorama and include chapters that would enable one to understand the voyages of exploration as part of a general problem of political history. I also had the idea of reaching a wider public in the hope that a book on science and technology would be of interest to other fields, such as cultural history or political history. The initial chapters on the 'discovery' of America, the *Casa de Contratación*, and cartography have been written by subsequent authors who have already studied those subjects in depth, so that here the book does not pretend to offer anything novel apart from finding relationships between aspects that are often treated in an independent way. By contrast, the chapters I have written on seamanship and natural history are mostly based on primary sources. Hence, from a theoretical viewpoint, and in view

30 López Piñero, José María, 'El arte de navegar en la [...]', op. cit.



of its effort to link different fields and subjects, the book may also appeal to readers who have a more specialized interest in the history of science and its relationship with the imperial history of the Atlantic world. For those reasons, the origin and depth of the chapters differ, but their combination is useful when it comes to thinking about a major historiographical problem: the shaping of a Eurocentric world order.

Summary of the chapters in this book

The first chapter discusses some of the main reasons why the Iberians embarked on grand projects of oceanic exploration and the impact that news of the first voyage of Columbus might have had on Spain. As an important part of this context, this section will refer to the geographical conditions of the Iberian Peninsula and the Atlantic, as well as the winds and currents that made that great ocean an ally of European expansion.

Chapter 2 discusses the institutions that were created in the framework of imperial expansion: The *Casa de Contratación* in Seville and the *Real Consejo de Indias* (the Royal Council of the Indies). Understanding the New World and controlling it from a distance required a complex bureaucracy, as well as norms and institutions whose sole aim was to ensure that there was a smooth and orderly flow of information and goods between Spain and its American possessions. Crossing the Atlantic was an endeavor linked to the land: the ship or fleet formed part of a larger project that cannot be understood without learning about its motivations and the complex institutions that were created for those purposes in Renaissance Spain.³¹

In addition to adequate vessels, voyages beyond the confines of the Mediterranean required new navigational techniques that were highly dependent on astronomy. The forms of orientation that characterized medieval navigation, that is, visual references, known winds, and the magnetic needle, were not sufficient on the great ocean. Portugal and Spain consolidated the new science of celestial navigation (*navegación de altura*), which was compiled in and spread by a set of texts and manuals that were read both in and beyond the Iberian Peninsula throughout the 16th century. These writings, most of which were printed or written in Seville, are the main source of this investigation, so that the third chapter discusses the most important manuals of navigation and cosmography that were

31 Ernesto Schäfer's study of the *Real Consejo de Indias* is an obligatory reference for this subject, which will be dealt with in Chapter 3.



produced in Spain in the 16th century, along with their importance for the history of Western science. Those books on seamanship and cosmography illustrate one of the central problems of this book: the tension between the classical authorities and the new experiences of the European explorers. The view of the New World that the first explorers of the New World had was determined by the ancient and medieval traditions of geography and natural history. The works of Aristotle, the astronomy and geography of Ptolemy, and Pliny the Younger's *Natural History*, among others, formed the frames of reference in which the natural world of America was interpreted. However, in order to transform the unknown world into something familiar, a renewed cosmography and a new natural history were required, so that the new could be incorporated into the traditions of classical learning. Learning about the New World showed the limitations of classical texts, but it was not possible to dispense with them either. In the end, the success of the European conquest of America lay in its ability to incorporate the unknown into familiar frames of reference.

As the central theme of this book, chapter 4 deals with the nautical knowledge, ships, instruments, pilots, and sailors. Any attempt at global rule presupposes the conquest of the ocean, since 70% of the Earth's surface is made of water. This allows one to argue that, in the study of the great geopolitical changes of the 16th century, sailing ships and sailors were the leading and decisive actors when it comes to understanding Europe's aspirations to world control. As we shall see, a single ship is a microcosm in which one can recognize the complex web of material and human aspects that were required to establish a stable link of control between the Old and the New World.

The knowledge and skills needed to lead a ship to its destination implied a complex division of labor and a linked sum of skills and functions. In the first place, the shipyards and the building of powerful vessels and navigational instruments—of fleets of ships equipped with costly hulls, masts, iron fittings, ropes, sails, and cannons—was already a technical challenge in itself, which entailed a combination and linkage of different resources and bodies of knowledge. Then, once at sea, the ships needed to be operated by a crew with many specific skills. Chapter 4 thus describes the ships, the activities that took place on these ships, and life aboard a transatlantic voyage, along with the difficult conditions of the crossing and the role of the religious beliefs of the mariners. Without faith and the will of God, the life and the activities of the seamen would have been meaningless.

The fifth chapter discusses one of the technological products that, in a more explicit and evident manner, represents European power over the

New World: maps. While this subject has been widely dealt with by others and, in fact, though the maps that will be analyzed in this book have been the subject of detailed studies, it is necessary to make a general reference to this subject. Navigational charts were powerful instruments of imperial expansion, and the new cartography of the world was the result of a linkage between classical traditions that spread in the Renaissance and the unprecedented experiences of voyagers. The power of cartography lies precisely in its capacity to encapsulate time and space on a flat representation of the Earth. It thus makes the world accessible: it is possible to take a Caribbean island to Madrid and put the whole world in a single place.³² As Bruno Latour indicates, men are the lords of the world only if the world reaches them in two-dimensional representations that can be combined and are easy to handle.³³

The sixth chapter gives an account of the main problems of the natural history of America. Once the enormous difficulty of crossing the Atlantic was overcome, the Spanish travelers faced a strange nature and the transformation of such nature into a domesticated world was the result of an arduous job of description and classification. Classical texts like the works of Aristotle, Dioscorides, or Pliny were the referent with which Europeans sought to understand nature in the New World. However, the flora and fauna of America were not to be found in the great encyclopedia of antiquity and creatures, such as the armadillo, iguana, or pineapple, among many others, defied the classical authorities and forced the naturalists of the 16th century to create a new natural history for a new world.³⁴ The local bodies of knowledge and tradition in America turned into sources that enabled Europeans to deal with the challenge of classifying and finding the possible uses of plants and animals that Christians had never seen before.

The final chapter goes back to this book's central questions about the role of Iberian science in the history of modern Europe. In that regard, the book sums up the work of other historians³⁵ who have pointed to the importance that a better understanding of the role of the Catholic and Iberian world in

32 Latour, Bruno, 'Drawing things together', in: Lynch, Michael and Woolgar, Steve (eds.), *Representation in Scientific Practice*, Cambridge, MIT Press, 1990, pages 19–68.

33 Latour, Bruno, 'La esperanza de Pandora [...]', op. cit., page 43.

34 A very complete study of this subject is found in the book by Miguel de Asúa and Roger French, *A New World of Animals: Early Modern Europeans on the Creatures of Iberian America*, Aldershot, England, Ashgate, 2005.

35 This section of book owes much to the studies and ideas of Antonio Barrera, Jorge Cañizares-Esguerra, María Portuondo, and Alison Sandman, who, in turn, draw on the studies done by a group of historians in Spain, among which José María López Piñero stands out.

the conquest of the Atlantic and New World has for the history of Western science, as well as the relation between the practices involved in that conquest and the emergence of a new science with pretensions of universality. It is not only Spain that has been ignored in the history of the birth of modern science, but also several fields of major importance for understanding science in the modern world, such as seamanship, geography, and natural history.

By way of a conclusion, we offer some reflections on the relations between the Spanish imperial endeavors of the 16th century and the history of Western science. The problem of knowledge, like that of control from a distance, is fundamentally a problem of communication, and by the same token, of the processes of compiling, organizing, and systematizing information. The institutions and supply centers that were created in Spain in the course of the 16th century, such as the *Casa de Contratación* of Seville and the *Real Consejo de Indias*, had a definitive role in the construction of a new world order and a new technical and scientific horizon.





Amsterdam
University
Press