While united by their adherence to a broad philosophical program, these Cartesians did not constitute an organized group but worked independently to further what they saw as the right and progressive philosophy. By far the most important Cartesian of the seventeenth century, however, was a French Oratorian named Nicolas Malebranche (1638–1715). A bolder and more systematic thinker than the others, Malebranche was not afraid to modify and even depart from Descartes's ideas in highly unorthodox ways. His occasionalism was thoroughgoing: God is the only real causal agent in the universe. All finite things are created and sustained in being by God, and all events, whether mental or physical, are brought about by the divine will. Creatures and their states are only secondary causes, or "occasions," for God to exercise genuine power. Malebranche also argued that the clear and distinct ideas that serve as the objects of human intellectual understanding are not modes or properties of the human mind but rather ideal archetypes in the divine understanding. With his theory of the Vision in God Malebranche sought to make human beings as dependent upon God for their knowledge as all creatures are dependent upon God for their being and activity. His doctrines were attacked by other Cartesians, most notably the Jansenist firebrand Antoine Arnauld (1612–1694), who thought Malebranche's ideas represented not only an unacceptable departure from the true principles of Descartes's philosophy, but also a serious threat to Christian faith.

By the third quarter of the century, Cartesianism, while vigorously condemned by leading religious and political authorities (in 1667 the French court prohibited a public funeral oration from being delivered at the ceremony for the reburial of his remains in Paris), enjoyed immense success. Nonetheless, it suffered from serious internal weaknesses and obvious explanatory failures. The advent of Newtonianism at the end of the century, with its alternative conception of scientific understanding, powerful mathematical presentation, and explicit critique of Cartesianism, brought about the final downfall of this formidable scientific paradigm.

See also **Aristotelianism; Descartes, René; Scholasticism.**

BIBLIOGRAPHY

Des Chene, Dennis. *Physiologia: Natural Philosophy in Late Aristotelian and Cartesian Thought*. Ithaca, N.Y., 1996.

Garber, Daniel. *Descartes's Metaphysical Physics*. Chicago, 1992.

Nadler, Steven M., ed. *The Cambridge Companion to Malebranche*. Cambridge, U.K., and New York, 2000.

Schmaltz, Tad M. *Radical Cartesianism: The French Reception of Descartes*. Cambridge, U.K., and New York, 2002.

Watson, Richard A. *The Breakdown of Cartesian Metaphysics*. Atlantic Highlands, N.J., 1987.

STEVEN NADLER

CARTOGRAPHY AND GEOGRAPHY. The recovery and diffusion of ancient literary and mathematical writings on geography in fifteenth-century Europe gradually transformed cartographic practices in the later fifteenth century. Earlier models of ordering space lacked uniform standards of denoting terrestrial continuity in mathematically consistent terms—nautical portolan charts noted distance and direction on magnetic compass lines for sea travel, itineraries measured paths of land travel, zonal maps divided the globe, while symbolic *mappae mundi* situated Asia, Africa, and Europe in a circle centered, for theological reasons, at Jerusalem. Renaissance geographic maps, by contrast, plotted the inhabited world as an interrelated network of secular space, translating the spherical globe onto a measured and ordered two-dimensional surface of fixed directions and proportions, as devised by the second-century Greek geographer Ptolemy, to frame a geometrically continuous representation of space.

Ptolemy's system of terrestrial coordinates, which appeared in fifteenth-century world maps, continued to be used to denote position and directions even after inaccuracies in Ptolemy's own projections were corrected. Maps made for manuscripts of Ptolemy's *Guide to Geography* in the century after its translation in 1406 challenged the existence of unnavigable "torrid zones" as well as Aristotelian concentric spheres of elements (water, air, fire), positing instead a network of global relations by transferring the earth's surface to a graticule that divided the surface of the earth according to metric

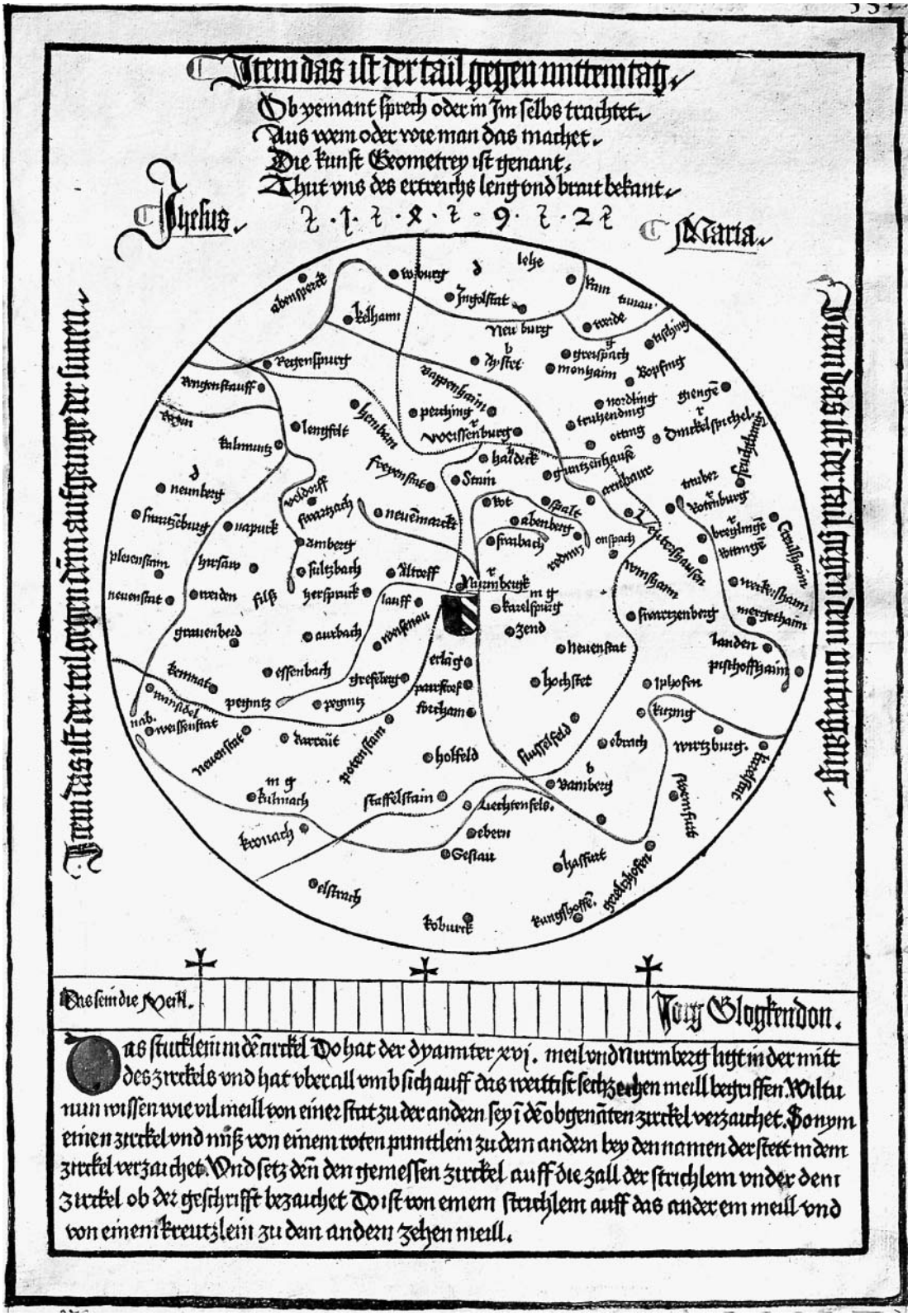
indices. The large circular world map that the Venetian monk Fra Mauro designed for King Afonso V of Portugal in 1459 had combined fifteenth-century navigators' accounts of the coast of Africa and the Indian Ocean with Marco Polo's (1254–1324) ethnographic accounts without using metric indices, pictorially illustrating the wealth of the Far East and showing its potentates and exotic fauna. Fifteenth-century geographic maps defined space within a directional grid, and their depiction of a terraqueous globe with east-west parallels of latitude and north-south meridians of longitude may have led Christopher Columbus to contest the Aristotelian model of the earth before Spanish royal cosmographers, natural philosophers who specialized in the relation of cosmic and terrestrial spheres and based their claims on celestial observations, in 1483–1484. The fact that Ptolemy reduced the earth's circumference probably encouraged Columbus's plans to "sail the parallel" to cross the Atlantic in 1492.

Map projections situated place-names in an abstract grid, creating a record of space that could be easily modified in the face of new discoveries. Printed maps emphasized a geometric organization of the world's surface from 1477 to later maps that included national boundaries (1482), and to the modernized Ptolemaic projections (beginning in 1513) showing the Americas as an independent landmass. Geographic knowledge expanded as Europeans became more familiar with routes beyond the Mediterranean world. Maps were seen as increasingly authoritative and thus could serve to clarify questions of territorial jurisdiction as European powers began to expand overseas. For instance, a Portuguese planisphere showing the African coasts and the Indian Ocean (1502) marked the meridian—960 nautical miles west of Ptolemy's prime meridian at the Canary Islands—by which the Spanish and Portuguese divided the New World at the 1494 Treaty of Tordesillas. (In Ptolemaic maps the Indian Ocean had been depicted as landlocked.) Spanish cosmographers helped resolve the disputes that arose over Ferdinand Magellan's 1519–1521 voyage, due to the limited accuracy of determining position by compass bearings.

Maps also reflected political agendas and cultural attitudes. For example, the French royal mathematician Oronce Fine devised a cordiform (heart-shaped) projection on a central meridian around 1536 in order to foreground France's proximity to the New World. His projection inspired Gerardus Mercator to map the post-Ptolemaic world on parallel meridians "properly adapted for use in navigation" in 1569, allowing sailors to plot nautical direction along fixed latitudes. While not immediately adopted by navigators—Pedro Nuñes's Defense of the Sea chart (1537) counseled the use of hydrographic charts instead—Mercator's projection increased the apparent size of Europe and placed it at the center of a global network, thus symbolically expressing European preeminence in the world. Matteo Ricci, the Italian Jesuit missionary to China, had to confront the Mercator map's bias when he redesigned it in 1584–1602 for a Chinese audience; to please his hosts, he moved China to the map's center.

The use of projections to correlate terrestrial positions served as a framework to mediate new understandings of geography and encouraged the exchange of geographic information. While navigational charts long struggled to map the earth's spherical form onto a two-dimensional surface, new techniques of projection encouraged the growth of descriptive geography. The mathematician Gemma Frisius explained the construction of surveying techniques by means of triangulation in 1533, facilitating the integration of regional maps into continuous projections by means of land surveying. The expanding use of triangulated surveys—which served to define boundaries, lines of property, and military fortifications—together with terrestrial projections encouraged the development of techniques of descriptive geography. Detailed qualitative maps of cities and regions, known as chorographic maps, were gathered in over forty-three editions of Sebastian Münster's *Cosmographia* (1544). Although the rise of triangulation is usually interpreted as the origin of objective and nonpictorial cartography, maps continued to depict topography, costumes, and other cultural features. In the 1570s printers in Amsterdam and Antwerp compiled atlases of considerable elegance, assembling world, regional, and city maps of both the Old and New Worlds.

Despite their claims of detachment from social contexts, maps of the New World reflected political, economic, and ideological interests. J. B. Harley has called attention to how maps serve different rheto-



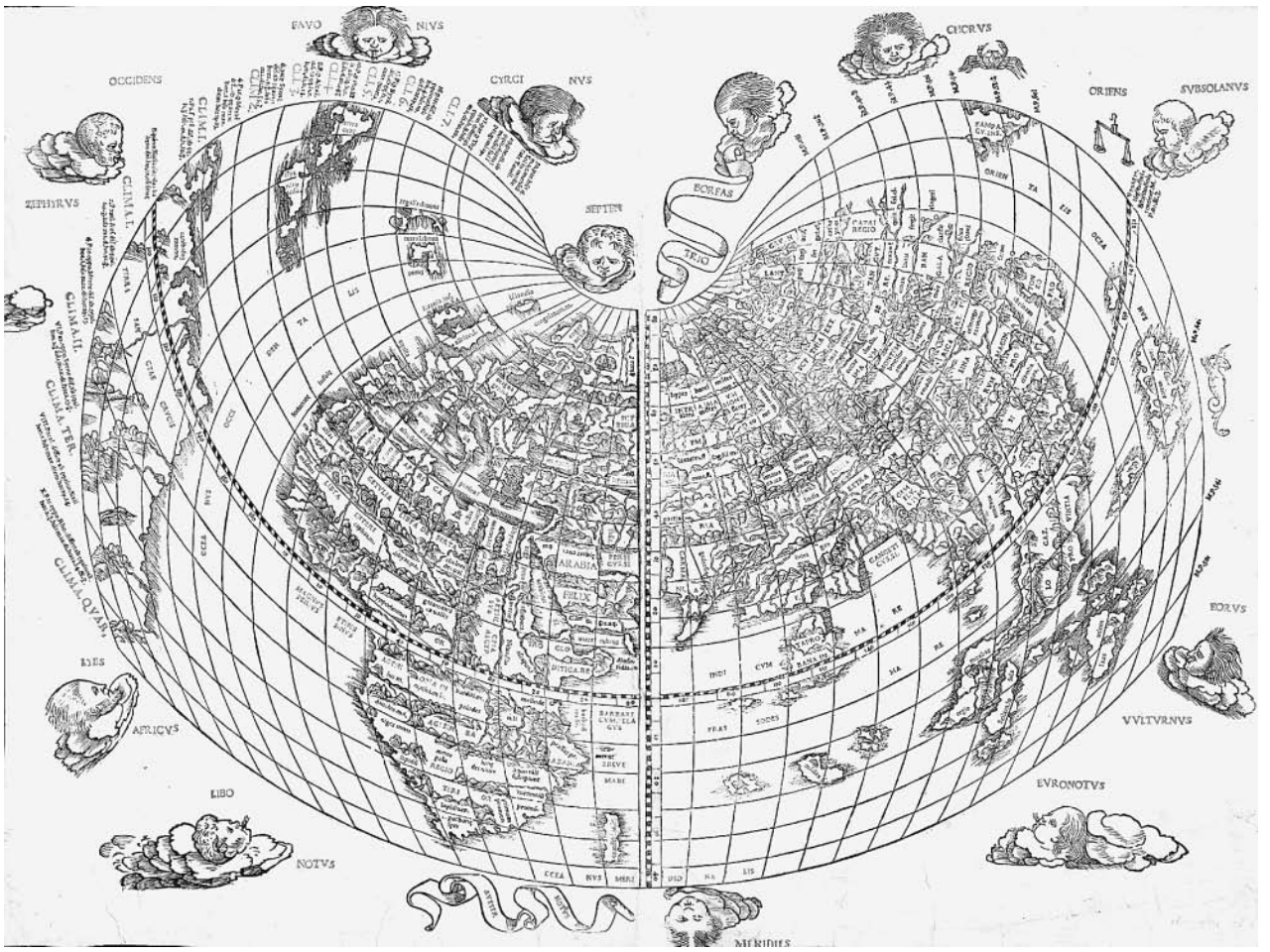
Cartography and Geography. This unusual circular map of the area around the city of Nuremberg, dated 1492, is from a copy of Hartmann Schedel's *Liber Cronicarum,* a pictorial history of the world. The text accompanying the map indicates that it covers a radius of sixteen miles from the center at Nuremberg and that it can be used as a distance indicator to the various surrounding towns by the use of the scale at the bottom. MAP COLLECTION, STERLING MEMORIAL LIBRARY, YALE UNIVERSITY

rical ends, by encoding relations of power, concealing information for political or economic reasons, and using allegorical decoration to further hidden agendas. For example, blank spaces in early maps of the Americas presented those territories as open to European conquest. Harley's arguments have stimulated scholarly work on the use of maps to assert claims of national identity in England and the Netherlands and to stake imperial claims in the New World. As Spain's overseas empire expanded, for example, a variety of maps served to demarcate boundaries of colonial jurisdiction and inscribe the relations of colonizer and colonized. Chorographies played a prominent role in images of frontiers, administrative maps, and military charts in both the Mediterranean and New World. The *Relaciones Geográficas* were commissioned by Philip II to map communities in the New World. The descriptive geographies of the Americas by Münster, Theodore de Bry (1590), and Jean de Léry (1578) glorified European conquest and helped foster a sense of European dominance, which was appealing to Europe's ruling classes.

From the late sixteenth century, mathematical geography included nautical charting. Geography became institutionalized as a tool for navigation and trade at the same time that the mastery of sea routes became a basis for staking national claims. This convergence of technological and political developments demonstrated the pragmatic uses of mapping the globe and thus encouraged wide interest in geography, while also promoting the acceptance of the Mercator projection despite its limited adoption by sailors. Martin Frobisher's search for the Northwest Passage in 1576–1578, Richard Hakluyt's *Principal Navigations, Voyages, and Discoveries of the English Nation* (1589; revised 1598–1600), and Edward Wright's (1561–1615) correction for magnetic variations in the North Sea all synthesized geography with navigation to promote England's imperial aspirations. Sir Walter Raleigh's use of explicitly commercial arguments in his 1596 protocol on the colonization of Guyana cemented the ties between geography and commerce. In response to competition from the Portuguese and the Spanish, state-owned concerns such as the Dutch East India Company (from 1602), the Dutch West India Company (founded 1621), and the Hudson Bay Company (1670) protected their maps as economic and state secrets.

Yet since most maps were confined to coastal areas, and until 1700 considerable interest was directed to mapping navigational routes, much inland territory of the world remained unmapped. There was continued reliance on nautical charting and neglect of inland areas in much of North and South America, driven largely by interest in locating El Dorado or the Northwest Passage. Around 1560–1580, long after Magellan sailed through the tip of South America, the limits of nautical cartography in the Pacific led cartographers to posit a southern "Terra Australis," in order to balance landmasses on the globe; this cartographical fiction only disappeared from maps around 1775, with the voyages of Captain Cook. Inaccuracies in mapping the size of the Pacific continued into the mid-eighteenth century, although global standards of longitude were widely accepted by 1650. Although world maps had described Africa from ancient times, Abraham Ortelius's 1573 map showing the mythical kingdom of Prester John continued to be reprinted for two centuries, and the interior of Africa was not mapped until the late eighteenth century. Similarly, classical constructions like the ends of the earth, or Antipodes, remained in the early modern geographical imagination even as more and more of the world's surface was mapped. The expansion of ethnographic geography, meanwhile, was stimulated by the travels of Jesuit missionaries among the American Indians (1637–1673) as well as collections of missionaries' maps of China in *Description de l'Empire de Chine* (1735) and *Histoire générale du Chine* (1777–1785; translated 1788).

The rise of geography as a mode of assembling facts stimulated increased scrutiny of the sources of geographical knowledge and of the expressive use of cartographic conventions, which helped to redefine cartography as an exact science. The emphasis on the accurate determination of longitude in large-scale eighteenth-century maps exemplified geography's increasingly descriptive function of measuring the earth according to fixed standards. The Bolognese astronomer Gian Domenico Cassini was summoned to Paris to found the observatory in 1669 for Louis XIV by Jean-Baptiste Colbert; there he determined the Paris meridian as a basis for the first large-scale general map of the



Cartography and Geography. Bernardus Sylvanus included two world maps in his 1511 edition of Ptolemy's *Geographia,* one of them this unusual cordiform or heart-shaped map in which he tried to incorporate knowledge from the new discoveries of the late fifteenth and early sixteenth centuries. It shows the Caribbean islands of Cuba and Hispaniola as well as the coast of South America and, in the North Atlantic, an island labeled ''Terra Laboratorus,'' possibly Newfoundland. MAP COLLECTION, STERLING MEMORIAL LIBRARY, YALE UNIVERSITY

nation. His successors provided similar large-scale topographic maps for political, military, and practical purposes. Official French maps inspired Peter the Great to plan the first map of the Russian empire in 1715, and in 1726 he commissioned French surveyors to map the country. In 1714 the British government, seeking a new tool to bolster its control of the seas, established a prize for the accurate determination of longitude at sea. The problem was finally solved in 1773.

Maps and atlases illustrated and organized power relations both in the home country and in its overseas imperial possessions while reflecting the increased precision of instruments. Atlases commissioned by gentry and nobility in eighteenth-century England defined rigid hierarchies of land ownership up to the 1791 completion of the Ordnance Survey, the first comprehensive synthesis of the nation undertaken for military ends. London became a ''clearinghouse'' for maps of Britain's imperial system. The first extensive survey of Bengal on a graticule of meridians and parallels by the surveyor-general James Rennell in 1765–1771 stressed political geography, reflecting the competition between French and British interests vying to control the lands of the Mughal empire; his map of India of 1788 illustrated the limits of British dominion and defined the subcontinent as a coherent geographic entity for the first time. In the course of the French invasion of 1798, Napoleon Bonaparte undertook a survey of Egypt based on the Paris meridian, in his

Cartography and Geography. Sebastian Münsters's map of Europe, oriented with south at the top, is one of twenty-one ''modern'' maps he included in his 1540 edition of Ptolemy's *Geographia*. MAP COLLECTION, STERLING MEMORIAL LIBRARY, YALE UNIVERSITY

desire to gain territorial compensation for France's loss of overseas colonies.

Given the authority invested in maps, cartographic conventions and iconography provided states with the means to stake territorial claims and visually express national identity. The prestige of geography as a natural science led Charles-Louis de Secondat de Montesquieu (1689–1755) to classify Europe, Asia, and Africa as *continents*—a term foreign to ancient geographic writing—in order to explain their cultural differences. The discrepancies in cartographic standards, however, remained striking, given the increased accuracy and detail in maps and atlases that disseminated geographical knowledge to ever wider audiences. Whether geographic maps functioned to register spatial locations or to depict objects of prestige, by 1800 they offered important tools for organizing and transmitting information within European empires and nation-states.

See also **Colonialism; Europe and the World; Exploration; Islands; Shipbuilding and Navigation; Travel and Travel Literature.**

BIBLIOGRAPHY

Campbell, Mary B. *The Witness and the Other World: Exotic European Travel Writing, 400–1600.* Ithaca, N.Y., 1988.

Cormack, Lesley B. *Charting an Empire: Geography at the English Universities, 1580–1620.* Chicago, 1997.

Cosgrove, Denis, ed. *Mappings.* London, 1999.