

investigation of \*Dietrich of Freiberg (early 14th century), which demonstrated that the primary \*rainbow resulted from a double refraction and a single internal reflection of light rays within individual raindrops.

The invention of something resembling modern experimental science has been claimed for two medieval figures: Robert \*Grosseteste and Roger \*Bacon. Such claims are now seen as serious exaggerations by most, if not all, historians of science, but Bacon's works do offer insight into both the theory and the practice of medieval experimentation. Bacon identified three 'prerogatives' of *scientia experimentalis*: submission of the conclusions of 'demonstrative' scientific arguments to the test of 'individual experience'; discovery of 'magnificent truths' in the other sciences, unobtainable by those sciences on their own; and discovery (and utilization on behalf of Christendom) of practical knowledge and lore not falling within any existing science, but discoverable through experience.

Bacon's scientific practice fell somewhat short of this theoretical stance. He advocated the collection and use of observational data in his scientific writings, though not with great frequency. He did make frequent appeals to what is commonly or universally known from everyday experience, but without suggesting that the empirical work had been done by himself. And in a handful of cases, we can produce a convincing argument for a theoretically relevant observation actually or probably made by Bacon—such as the measurement of the maximum elevation of the rainbow as 42° (a correct figure first stated by him).

As for the functions served by observations or experiments, actual or recommended, in Bacon's scientific works, some were intended simply to discover or verify factual data, without regard for theoretical utility. Most, however, were employed to confirm, refute, or challenge some theoretical claim or to yield phenomena requiring explanation—offering thereby an opportunity to display the theory's explanatory power. See also SCIENCE IN CHRISTENDOM.

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A. C. Crombie, *Robert Grosseteste and the Origins of Experimental Science 1100–1700* (1953).

J. M. G. Hackett, ed., *Roger Bacon and the Sciences: Commemorative Essays* (1997).

D. C. Lindberg, *Roger Bacon and the Origins of Perspectiva in the Middle Ages* (1996), lii–lxvii.

A. I. Sabra, ed. and tr., *The Optics of Ibn al-Haytham, Books I–III: On Direct Vision*, 2 vols (1989), vol. 2, 14–19.

R. W. Southern, *Robert Grosseteste: The Growth of an English Mind in Medieval Europe* (1986).

L. Thorndike, *A History of Magic and Experimental Science*, 8 vols (1923–58).

and colonization are two sides of the same coin; that internal colonization preceded external; and that exploration and colonization depended upon the economic system of the time.

1. Structure and origins
2. The process of colonization
3. From 'medieval' to 'early modern' models

### 1. Structure and origins

Medieval Latin Christendom manifested itself as a network of sees supported by agricultural tithes and rents. Along with this was a political structure of bishops and lords enforcing notions of proper marriage and inheritance practices and property tenure, as visible in, for example, \*Charlemagne's capitulary for newly conquered \*Saxony. Colonization may be seen as the imposition of a socio-economic order upon lands not habituated to it.

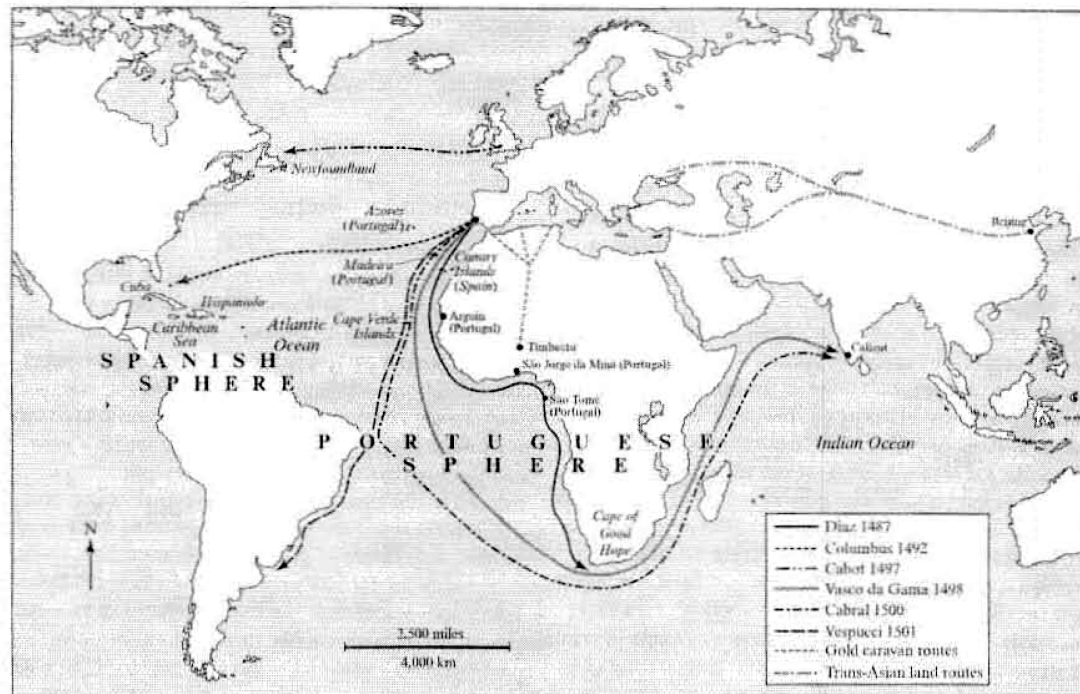
However, the first frontier was internal. After post-Carolingian decline, the amount of cultivated arable was expanded, supporting a growing population that could be employed in further ventures (for example, dyke-building and drainage in the \*Low Countries). Internal expansion helped form Latin Christendom, through the exportation and adaptation of social forms from core to periphery.

### 2. The process of colonization

The main theatres for external expansion were eastwards, into the area around the \*Baltic Sea and eastern Europe; southwards, into the Muslim and eastern Orthodox Mediterranean; westwards, in the Iberian \*Reconquista, as well as the AN venture into Wales and Ireland; and Scandinavian expansion into the north Atlantic and beyond.

Merchants' and missionaries' forays were often not intentionally expansionistic. Missionaries are well documented, while our knowledge of other pioneers—merchants, mariners—depends on accidents of survival. Society-wide colonization might be prompted by various motives: desire for profit, a wish to avenge the killing of missionaries or merchants, or a local ruler's invitation. The invaded land and its resources were enfolded into the invader's socio-economic organization. This organization also informs the ideological justification of conquest, labelling the enemy as the 'Other', and generating mass enthusiasm. This tendency informs medieval explorers' tropes of foreign cultures: it is on marginal lands, places where the economy and its property relations do not hold, that order breaks down and one finds 'monsters'. For example, \*Gerald of Wales details the 'improper' Welsh and Irish ecclesiastical organization and these peoples' penchant for marriage within the forbidden degrees of separation—both growing out of Celtic peoples' pastoral economy and clan organization: this provided justification for \*Henry II to invade. Likewise, travel accounts

**exploration and colonization** Study of the medieval origins of the expansion and consolidation of western civilization leads to three observations: that exploration



Early transcontinental exploration, 1487–1501.

of the \*Mongols always mention their marriage customs and property division.

Where more sophisticated methods existed, they were quickly adopted. The Normans in Sicily adopted the monetized bureaucratic system already in place; likewise, the \*crusader states found the 'protected people' and tax systems of the Levant useful. Rulers in the Mediterranean and Iberia made use of Muslim and Jewish officials, and acculturation through sexual alliances naturally occurred. The importance of women also held true where the colonization model was one of repopulation. In Iberia, the military conquerors were men, but it was women who were encouraged to settle and raise families. Colonization can also be seen as a matter of accommodation and the forging of bicultural identity.

### 3. From 'medieval' to 'early modern' models

If colonization depends on economic organization, then the \*Canary Islands exhibit the change in modes of colonization from a 'medieval' to an 'early modern' model that better characterizes the conquest of the New World. The first European settlement in the Canaries lasted for two decades from 1312 until the indigenous Guanches revolted. After 1402 the permanent conquest by Jean de Béthencourt, a Norman, began a link to the Iberian paradigm of conquest and incorporation into the feudal economic system. The overall economic model was, as on the peninsula, one of

peasant smallholdings. However, by the late 15th century, conquest was undertaken by crown mercenaries, and then land could be given to large-scale tax-paying cultivators employing slave labour. See also CISTERCIAN ENTREPRENEURS; COLONIALISM; FRONTIERS AND FRONTIER SOCIETIES.

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D. Abulafia and N. Berend, eds, *Medieval Frontiers: Concepts and Practices* (2002).

R. I. Burns, *Muslims, Christians, and Jews in the Crusader Kingdom of Valencia* (1984).

H. Dillard, *Daughters of the Reconquest* (1984).

F. Fernández-Armesto, *The Canary Islands After the Conquest* (1982).

T. Glick, *From Muslim Fortress to Christian Castle* (1995).

J. R. S. Phillips, *The Medieval Expansion of Europe* (1998).

A. M. Stevens-Arroyo, 'The Inter-Atlantic Paradigm: The Failure of Spanish Medieval Colonization of the Canary and Caribbean Islands', *Comparative Studies in Society and History*, 35 (1993), 515–43.

W. Tebrake, *Medieval Frontier: Culture and Ecology in Rijnland* (1985).

**expositio missae** An allegorical commentary on the texts and actions of the \*Mass. The genre emerged in the Carolingian Empire and flourished throughout the MA. SB  
T. Thibodeau, 'Western Christendom', in *The Oxford History of Christian Worship*, ed. G. Wainwright and K. B. Westerfield Tucker (2006), 237–42.