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'to finde out the pathe' Mapping the Universal Machine in William Cuningham's *Cosmographical Glasse* (1559)

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Abstract

The article places *The Cosmographical Glasse* (1559), William Cuningham's *magnum opus*, in its English and European context. *The Cosmographical Glasse* appeared during the early modern revolution in mathematics that turned mathematics to practical use by applying it to geography for a better conceptualisation of the globe and universe. Despite the work's encyclopaedic scope and its author's pioneering attempt to help readers retrieve the growing body of data that was being amassed by scholars and explorers, the article argues that this first book in English to deal with navigation in relation to astronomy and cosmography stood at a crossroads between the old and new epistemologies as geography both resorted to and confirmed traditional sources of knowledge while challenging them. Limited and flawed as it may be, *The Cosmographical Glasse* nevertheless added another building block in the construction of a modern sense of cosmography.

Keywords: *Franciscus Maurolico, John Daye, Robert Dudley, Robert Recorde*

1. *Introduction*

William Cuningham (sometimes spelt Kennyngham or Kenningham) has been identified as the sitter for a set of three identical woodcut portraits in the National Portrait Gallery (NPG).[1] The original design comes from the opening pages of *The Cosmographical Glasse* (Aiiiv), though an earlier less refined woodcut is to be found in the 1558 edition of Cuningham's *Nevve almanacke and prognostication* (Aiir). Just as the portraits mirror each other, the identity of William Cuningham (1531-c. 1586) somewhat eludes grasp since there is little information

[1] NPG D25463, NPG D25464, and NPG D25465.

about his life and career. His magnum opus, *The Cosmographical Glasse conteinyng the pleasant Principles of Cosmographie, Geographie, Hydrographie, or Nauigation* (hereafter *CG*), was entered by its publisher John Daye in the Registers Office on 6 November 1559, a week after receiving the first-known Elizabethan patent (*CG*, 209; Arber 1875, 47; Evenden 2016, 60). For different reasons this work was a milestone: it marked the first appearance in England of the apostrophe and of the double-pica italic type developed by the typographer François Guyot; it contained the earliest surviving complete printed map of an English provincial town (Norwich), and finally, it was the first book published in English to deal with navigation in relation to astronomy and cosmography (Buisseret 1992, 52; Pignot and Piton 2009, 4; Evenden 2016, 59). Despite its appealing novelty and lavish presentation, Cuningham's work did not go through a second edition. John Parker believes this lack of success originated in the book being a disappointment, 'demonstrat[ing] no great erudition on the part of its author' (1960, 49). Mary C. Fuller concurred, arguing that Cuningham did not seem to have been well acquainted with 'the formal or informal knowledge returned to Europe by sixteenth-century mariners'; furthermore, there was no mention of the Copernican theory of the cosmos (2013, 22). David W. Waters argued, however, that *The Cosmographical Glasse* could not be accused of not being up to date simply because it did not contain any reference to Copernicus since this charge could equally be applied 'to standard books on the subject written a century later' (1958, 98). An undeniable proof that the work had nevertheless something to offer English navigators was that together with Robert Recorde's *The Castle of Knowledge* (1556) it was one of the few books forming Martin Frobisher's library when he set out to find a North-West passage to Cathay in 1576. One of Gabriel Harvey's books contains marginal annotations, some of which refer to *The Cosmographical Glasse* (Collinson 1867, x; Johnson 1937, 192). If *The Cosmographical Glasse* did have faults and limitations, William Cuningham was nevertheless a pioneer whose purpose was to bring some of the latest European discoveries to his readers even if there were epistemological boundaries he was not willing to cross.

It is relevant to start with the English and European intellectual circles Protestant, Norfolk-born and Cantabrigian Cuningham was part of or acquainted with in order to discover how he obtained information on the New World, with the exchange of ideas, references and manuscripts thanks to his belonging to the Dudley intellectual circle. The second aspect that needs to be addressed is his design, that is how he chose, organised and developed the data taken from previous or contemporary sources. Finally, we will discuss Cuningham's representation and narrative of the New World to highlight that approximate though it might be, *The Cosmographical Glasse* established temporary bounds within a field of constantly evolving knowledge.

2. *Cuningham and Europe's Intellectual Circles*

Cuningham was a member of intellectual circles in England both in Cambridge and London. His early years in Norwich ended when he settled in Cambridge to read the arts. He was admitted as a pensioner at Corpus Christi in 1548, matriculated in Easter 1551 to finally graduate BM in 1557. *The Cosmographical Glasse* provides a glimpse of his whereabouts at the time, testifying he had returned to Norwich in November 1556 to make astronomical calculations that were renewed there in March 1557, November 1558 and July 1559 (47, 92 and Aviv). The cosmographer spent much of Mary I's reign abroad, journeying to some of the Protestant-friendly cities of the continent, travelling in 1558 to Heidelberg where he acquired his doctorate and probably to Strasbourg, Antwerp and Cologne, cities he was familiar with (180-181 and 19). He returned to England and put the finishing touches to *The Cosmographical Glasse* which he completed 'at

Norwich, the xviij. of Iuly 1559' (Aviv). In 1563 he was appointed public lecturer at the London Barber-Surgeons' Company, during which time he lived in Coleman Street close to Aldersgate where John Daye's printing house was situated. Cuningham's credentials as a physician were so impeccable that he collaborated with the eminent royal naval surgeons Thomas Gale and John Halle while finishing two works, 'one of Phisique, an other of chirurgie, which you shal presently enioi' (1566, Ciiv; Fay 2015, 62). His life-long interest in astrology attracted attention but also criticism from 'some yet ignorant' who mistook 'this noble scie͠ce' for 'execrable, and da͠nable practice of Necromancie, Sorcerie, & witchcraft' (1558, Aiiv): in 1560 the Puritan William Fulke led a sustained attack against 'Master Cunyngham' the prognosticator, though 'a man otherwise bothe lerned and honest' (1560, Cviiir, Br). This printed censure may explain why John Daye at that point ceased collaborating with Cuningham even though there remained a lively public interest in prognostications. Cuningham's later works were published by other London printers. He did not, however, stop writing on astrology, putting to print a (now lost) Latin work on the methods of prognostication (1566, Ciir). Astrology was not his only pursuit and his intellectual range is indicated by the list of works announced in *The Cosmographical Glasse* as his intention was to present his patron with his 'laboures', whose titles where, among others, *Organographia*, *Chronographia*, 'VVith diuers others, whose names I omit for sondry causes' (Aiiv). Some were lost, some only circulated in manuscripts while others were certainly never written, Cuningham blaming his 'weake body, and croked fortune' for his failure (1566, Ciiv).

Cuningham was also a member of continental academic circles. He records his visit in 1558 to the university of Heidelberg, his impression of the university and the scholars he met there:

> à florishing Uniuersitie, mainteined by the Palsgraue, … [that] florished 1559 [sic] in Phisicke, D. John Langius, the Princes Phisician, Iacob Curio, Thomas Erastus, Petrus Lotichius Secundus, all Doctors in Phisick: And D. Balduinus the Reader of the Ciuill Lector, with diuers others, of whom I was very gently interteined at the time of my Commensment. (*CG*, 181)

The university was supported by the Elector Palatine Otto Henry who had instituted a wide-ranging overhaul of the university's programmes as well as the recruitment of reputed scholars. John Langius was physician to four successive Electors palatine; Peter Lotz was a Professor of botany and medicine, Thomas Erastus was Professor of medicine while Jacob Curio, a mathematics and medical Professor, had been appointed the university's first chair of mathematics. These influential, well-travelled and widely learned scholars specialised in mathematics, botany and medicine, the latter Cuningham's future occupation. The region of the Rhine – and particularly Basle, Strasbourg and Saint-Dié – that Cuningham visited had close ties with humanist learning and the book trade (Bierma, *et al.* 2005, 1528; Davis 2011, 533-534). *The Cosmographical Glasse* is indebted to the influence of this continental network for its presentation of the triangulation method – a modern technique used to fix the location of other sites within a triangle and determine the latitude and longitude of places – originally used by the Flemish cartographer and at one-time cosmographer to Charles V Gemma Frisius in his *Principles of Astronomy and Cosmography: with Uses of the Globe*, first published in Latin in 1530. Cuningham, the first author to present the method in England, simply adapted it with the Norfolk cities Norwich, Wymondham and Swardeston as landmarks (*CG*, 139-140; Heninger 1969, 123; Dekker 2002, 38). While on the continent he became acquainted with Thomas Langley and Gilbert Berkeley, both Marian exiles, who praised *The Cosmographical Glasse* in the Latin address adjoined to the work (Aiiir). Cuningham's own religious convictions are not too overtly expressed in *The Cosmographical Glasse* since it was written during the Marian years. In the bird's-eye view map of Norwich for instance he briefly referred to 'the place where men are customablie burnt' (n.p.). Between 1557

and 1558, about ten people died at the stake, Protestant martyrs whose death he might have witnessed. If he had in any way attended Reginald Pole's visitation of Cambridge in January 1557 or the posthumous burning of Paul Phagius and Martin Bucer the following month, he remained silent about it, which might mean he was already away.[2]

In England, the circle of intellectuals and academics with an interest in astrology, mathematics and map-making evolved, among others, around Robert Dudley who was not yet elevated to Earl of Leicester in 1559. Authors who wanted their works published, Stephen Pumfrey stresses, first had to negotiate with the secretaries of influential men, such as Dudley, Raleigh or Northumberland, so as to know whether the patron wanted the work published and his name associated with it. If he did, he then would normally become the dedicatee. The author would have had a scribe to prepare a fair manuscript copy, presented as a gift to the dedicatee, for the patron and his circle to assess the value of the work. If the patron accepted, he would carry the expense of the printed edition and the work would be sent to a press (2012, 144). Cuningham for instance presented *The Astronomicall Ring* to the 'late [2nd] Earle, Henrye Sussex' Henry Radcliffe, who had died early in 1557, but this work is no longer extant, perhaps because Radcliffe refused to have his name associated with it (1558, Aiiv-Aiiir; *CG*, Aiiv). Or was it Radcliffe's untimely death that put an abrupt end to the process? *The Cosmographical Glasse* is dedicated to Dudley and Cuningham's praise of his 'incoragement of me to knowledge, bothe in wordes and moost liberall rewardes' (*CG*, Aiiv) yielded hopeful results as the author obtained the patronage of Elizabeth's favourite and a £6 13s. 4d. allowance in 1558 'at his [Cuningham's] going into Flanders' (Dudley 1995, 66). The connections between the members of the Dudley circle proved useful for physicians too: the royal naval surgeon Thomas Gale, whom Cuningham collaborated with, was one of Dudley's earliest protégés. Cuningham had had different occasions to come into contact with John Dudley, Robert's father: Edward VI's Lord president who had been Lord Admiral since 1543 was the chancellor of the University of Cambridge between 1552 and 1553; the Dudley family had connections with Norfolk as they had purchased extensive estates there in 1553. The tight-knit intellectual community brought various scholars together when John Dudley, who was particularly interested in navigation, wanted his children to have the best scientific education available. John Cheke and William Cecil, with whom Dudley was acquainted, introduced the Lord Admiral to a possible teacher who had returned from Louvain: John Dee eventually got the position of tutor to the Dudley children. Dee's lessons must have encouraged Robert Dudley's keen interest in mathematics and geometry. It was Dee who recommended Cuningham's book to Frobisher (French 1972, 32; Baldwin 2006, 99; Loades 2006, 226 and 246). Dee's influence is noticeable in Cuningham's description of Muscovy and narration of the 1553 expedition in search of the Northeast Passage that was led by Hugh Willoughby and Richard Chancellor.

> Moscouia is à longe & ample Regiō, the people miserable, suspicious, & craftie, the chief citie of ther Empirour is also called Moskaua. Thither sailed out of England. 1553 Chancelour, & diuers other. The nature of th'inhabitantes, cōmodities of the coūtry, & à perfite description of all the parts of the same you shal se at large set oute by Sigismunde Liber baron &c. (*CG*, 182)

The Imperial diplomat Sigismund von Herberstein's treaty *Rerum Moscoviticarum Commentarii* published in Vienna in 1549 evoked the existence of a Northeast Passage to China via the Arctic

[2] In 1557 Simon Miller and Elizabeth Cooper were burnt in July, Richard Crashfield in August, and Cicely Ormes in September, William Symon, Thomas Hudson and Thomas Carman in May 1558, and Richard yeoman the following month, but Cuningham was then on the continent. See Foxe 1570, 2142-2154, 2197, 2219, 2244 and 2272, available from: <http//www.dhi.ac.uk/foxe>, accessed 1 February 2023.

Ocean. As Samuel H. Baron demonstrated, the treaty was known in some English circles and was probably used by Sebastian Cabot, John Dee and Richard Eden in order to prepare the 1553 expedition (1985).

Even before his meeting with Dudley, Cuningham might have seen John Dee when he was at Cambridge between 1551 and 1557: returning from Louvain in 1551, Dee went back to Cambridge to offer to Trinity College and St John's College a variation compass, a clock by Dibbley, two Mercator globes, a magnet stone (lodestone), and a large astronomical quadrant brought from Gemma Frisius (Baldwin 2006, 97-98). Dee's plan to stimulate the study of cosmography came to a successful conclusion: with Cuningham's publication, the University of Cambridge produced its first original work on the subject. Mathematician, astrologer and map-maker, much-travelled and widely-known, Dee played a decisive role in the intellectual development of early modern England due to his belonging to a remarkable continental network of scholars involved in, among other areas, the cosmographical art. He attracted as students and friends men of stature like Gemma Frisius, who had been Dee's professor, Gerard Mercator, the great cosmographer, globe-maker and producer of navigational instruments who had also been Frisius' student, Oronce Fine, the Professor of Mathematics at the Collège de France and one of the most important contemporary French geographers; as well as Abraham Ortelius whom Dee met in Antwerp (Taylor 1968, 26; French 1972, 177; Delano-Smith and Kain 1999, 59; Baldwin 2006, 97-99). These authors and their works were to have a considerable influence on *The Cosmographical Glasse*. Apart from Dudley and Dee, the printer John Daye must have played a pivotal role in Cuningham's career as a cosmographer for in 1556 he published Leonard Digges' *Book named Tectonicon* that introduced measurement and instrumentation (Oastler 1975, 12). Finally, thanks to William Cecil's backing, *The Cosmographical Glasse* received its patent easily and quickly. As Hakluyt remembers in Cecil's chamber he had 'found lying open vpon his boord certeine bookes of Cosmographie, with an vniversall Mappe' (1589 *2). With Cuningham's cosmography as a forerunner, Cecil perhaps wished to test the market so as to see how popular works on navigation would be received under Elizabeth, or he was simply eager to further the field (Oastler 1975, 12; Evenden 2016, 60). That *The Cosmographical Glasse* only ran to one edition means that the public was small but not that they were uninterested. The impressive scale and high cost of *The Cosmographical Glasse* militated against it ever becoming a popular work and being reprinted. In the preface, Cuningham actually expressed his gratitude to Daye for the 'charges … [he] hath susteined, … that shalbe euident conferryng [comparing] his beautiful Pictures & letters, with suche workes, as herto hath bene published' (Aviv).

3. *Cuningham's Method*

David S. Berkowitz contended *The Cosmographical Glasse*, 'the first substantial English work on mathematical geography and astronomy … had a thorough academic character' (1965, 54) and yet, Cuningham vulgarized scientific knowledge for popular consumption, devising his work with the intention to set forth the rudiments of cosmographical knowledge in a concise and accessible form: 'that the praeceptes myghte seme the more facile & plaine, I haue reduced it into the forme of à Dialoge (sic)' (*CG*, Avi r-v). The folio is divided into five chapters and structured, the fifth chapter excepted, in the form of a didactic discussion between Philonicus, the teacher/author who offers precepts and answers to his pupil Spoudaeus' questions. Just as Plato's Socratic exchanges, this means of intellectual inquiry was supposed to gradually lead the pupil to the understanding of the truth. The disputation is also cast in theatrical terms as the interlocutors are 'in dede fained' (Aviv); the first two chapters open with a soliloquy on nature and the cosmos by

the pupil who, finally espying his master in the distance, walks towards him, telling the reader about the meeting. *The Cosmographical Glasse* is in a handsome italic, as Mark Bland stresses, the double-pica italic type being actually used to indicate 'a different voice in the text … often linked with humanist concerns [and] … intended as a direct representation of speech' (1998, 97-98). Cuningham chose English 'to serue the unlerned multitude' as well as to achieve clarity of thought and of expression in order to communicate old and new concepts (*A&P* 1566, Ciir). That he was 'writing to Englishe men' ensured his work would only have a local impact (*CG*, 57). Realising that cosmographies 'ether … obserue no order, or Methode in their teaching, ether that they digresse from that they take in hande (and fyll their volumes with other sciēces', Philonicus explains he will do his outmost 'to suplie that wante in that behalfe' (3-4). Finally, the work is geared towards the retention of information providing an extensive index 'for the spedier findynge of suche thinges, as you require' (n.p.), repeating the main points taught and learnt at the end of the chapters and making lavish use of engravings, tables, graphs and diagrams to illustrate, demonstrate, simplify and adorn.

The Cosmographical Glasse is addressed not only to those who 'are delighted in trauailing as well by land, as water', but also to fireside travellers up and down the realm who might enjoy exploring 'the hole face of all th'Earthe' without leaving the comfort of 'à plesaunte house, or warme study' (Avir). Cuningham pitted the hardships of traveling through the known world against comfortable and safe map-reading, fully exploiting the parallel with drama that made the invisible become visible, as well as the different meanings of *oikemene*, a word which combines the senses of world and house (Gillies 1994, 5). Each of the five books covers the different sciences of astronomy, geography, cartography, navigation, and chorography. Cosmography as it was understood in the sixteenth century included the division of the world into five circles – the meridian, the horizon, the polar circles, the colures, and the equator – as well as the conception of a relationship between the Earth and the heavens (*CG*, 7). Following the sixteenth-century hierarchy of representation – cosmography, geography, and chorography – initiated by the German Peter Apian in *Cosmographicus Liber*, first published in 1524 (Cosgrove 2007, 55), Cuningham distinguishes between cosmography which 'describeth the [vniversall] worlde, Geographie th'earth: in lyke sorte Corographie, sheweth the partes of th'earth, diuided in them selues' (6-7). In his Preface the author lists the manifold profits of this art that benefits the defence of the country, the study of divinity, medicine, poetry, trade and navigation. 'Cosmographie is not vnfrutfull. For she setteth out the natures of all people, the lawes and statutes by which they are governed, & the sequele of euery decre established … Cosmographies … [give] the names of Regions, Cities, Townes, waters, fluddes, mountaines, ceremonies, people and monsters' (Avr).

A survey of the sources used by Cuningham shows that his major authoritative influence was naturally Ptolemy (mentioned about twenty times), followed by Strabo (mentioned seven times), Aristotle and Proclus (five times), the contemporary Oronce Fine (four times), Polybius and Hipparchus (three times).[3] The work's frontispiece functions as a testimony (figure 1): above the central cartouche is a large terrestrial globe; on the left Ptolemy looks at the stars to which he points his right finger while his left hand rests on the meridian of the globe near the North Pole; below Aratus holding a dial and Hipparchus a quadrant. On the right, Marinus measures with callipers something on the globe; below Strabo draws a map of England and Polybius uses a cross-staff. The title page is thus divided with, on the left, astronomers scrutinising the stars and, on the right, geographers measuring the earth. Traditionally, the quadrivium of the

[3] These figures rely on my indexing as Cuningham's is quite extensive yet fragmentary.

seven liberal arts included geometry, astronomy, arithmetic, and music – as indicated in the lower part's representations of the muses with their proper symbols. Astronomy, geometry, arithmetic and music played a central role in cosmography whose purpose was to reveal the divine mysteries of harmony, symmetry and pattern.

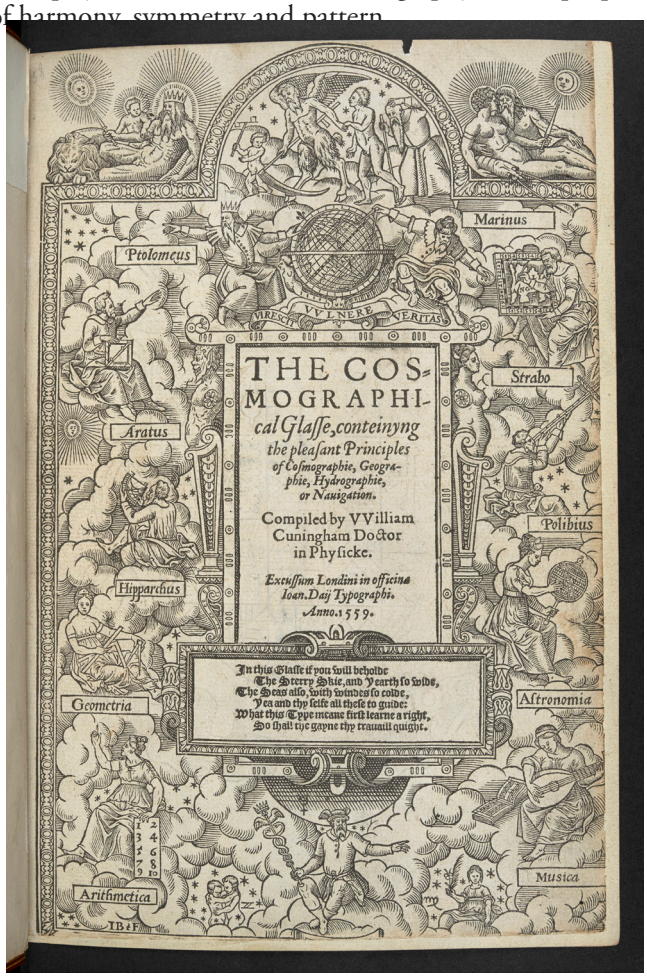


Figure 1 – Frontispiece. By permission of the British Library

Apart from these traditional authors, Philonicus advises Spoudaeus to read contemporary books on arithmetic and geometry such as 'our worthy countryman, (… John de Sacrobosco)', to which Spoudaeus replies he has read Robert Recorde's *Ground of Artes*, *Pathway to Knowledge* and *Whetstone of wytte*, to which can be added *The Castle of Knowledge*, published respectively in 1543, 1551, 1556 and 1557 (*CG*, 14, 4 and 51). Recorde (c. 1512-1558), a Welsh private mathematics tutor at Oxford and Cambridge, had prepared a series of mathematical textbooks to disseminate the new knowledge, choosing the format of the dialogic presentation with an effort to reproduce the speaking voice and a step-by-step explanation of every operation. Both Cuningham and Recorde made independent astronomical observations, drew on a wide range of sources from Antiquity to the early modern period, and offered instructions on how to make

instruments or produce a mathematically-oriented description of the earth.[4] *The Cosmographical Glasse* is often considered as the rival, copy or continuation of Recorde's *Castle of Knowledge*, where the author expressed his unfinished plan to write a cosmography (Heninger 1969, 124), but Cuningham in fact largely drew on *Cosmographia, in tres dialogos distincta*, published in 1540 by the Italian mathematician and astronomer Franciscus Maurolico (1494-1575): the typography is the same, the format is a dialogue between Nicomede and Antimache, while numerous pages in *The Cosmographical Glasse* are a simple copy of Maurolico's cosmography[5]. The most blatant example found in *The Cosmographical Glasse* is a translation of *Cosmographia*:

Parallelus oppositus ei, qui oer Canariá, it per Nili fontes, montémque Lunae.
Oppositus ei, qui per Syanen, it per insulas Médacascar, Peutam, Necurá, lauam maioré Candin, regnúmque Coilum.
Oppositus ei, qui per Damascum, it per Bonae speu promontorium.
Oppositus ei, qui per Rhodum, it per insulas Seilan & Angama. …
Italiae antipodes sunt, qui lauam minorem habitant.
Lusitanorum antipodes sunt insulae Seilam incolae. (Maurolico 1540, 101)

As the parallele (opposite vnto the North parallele, which goeth by the Canarian Ilands, is drawne by the Riuer Nilus, and Mons Lunae, the Mount of the Moone.
The parallele opposite to that which is drawne by Syëne, goeth by the Ilandes Mendacascar, Peuta, Necura, the greater Iaua, Candin, and the kingdome of Coilum.
The parallele opposite to that whiche is drawne by Damascus, goth by the promontory of good hope, called promontorium bonae Spej.
The opposite parallele, to that goeth ouer the Rhodes, is described by th'Ilands Seilan, & Augama. & they are antipodes vnto Italy, which dwell in Iaua the lesser. The antipodes to the Lucitanians, are those in the Isle of Seila. (*CG*, 80)

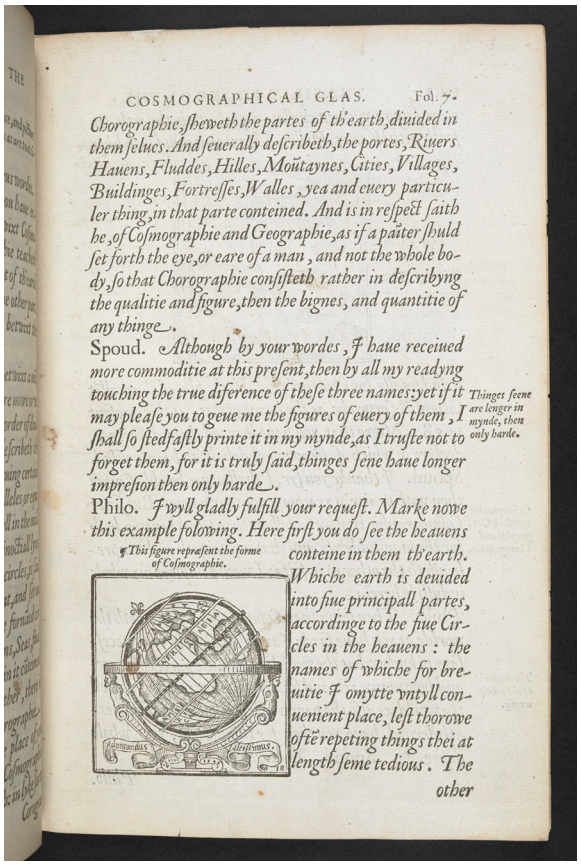
Cuningham may have come across Maurolico's work while studying medicine and mathematics on the continent. Though he mentions the Italian mathematician, astronomer, astrologer, and physician Campanus of Novara (c. 1220-1296), there is no mention of Maurolico. The recycling or copying of sources did not mean that Cuningham merely imitated: he included his own and others' observations to correct former authors' statements ('this waye also, is excellente to correcte the course of the Mone, and amend the tables, out of which hir mouinges are taken: if they do erre at any time') or to complete his fragmentary information ('therfore receiuinge … obseruations at other mens handes', *CG*, 108 and 118). Cuningham, like his contemporaries, 'did not just read texts to learn from them in a disinterested process of self-edification: he read them to use them' (Sherman 1995, 60). The end of this goal-oriented activity was either intellectual (to improve the transmission of inherited texts) or political (to apply their reading to the advancement of the commonwealth). 'One of the key strategies guiding scholarly [reading] practices during the sixteenth century was the collection of a thesaurus ("treasury" or "storehouse") of useful phrases, images, and ideas. Annotations entered directly in the margins of books were [also] a common and economical method' (*ibid.*). Mathematics had been closely associated with

[4] Cuningham reproduces passages, maps and tables from *The Castle of Knowledge* (*CG*, 13, 15, 26, 64, 30, 31 and 76; *The CK*, 9, 18, 28-29, 64, 166, 168 and 192). Due to the date of publication (1556), Protestant Recorde dedicated *The Castle* to Mary I, 'by the grace of God Queene of England, Spain, bothe Siciles, Fraunce, Jerusalem, and Irelande: Defendour of the faithe' and inserted a Latin address to Reginal Pole.

[5] Passages in Maurolico (11, 23, 37, 62, 66, 69, 70, 85 and 154) are echoed or copied in *CG* (35, 77, 42, 109, 53, 94, 32, 65 and 62).

astronomy since the Alexandrian astronomer and mathematician Claudius Ptolemy had given precise mathematical analyses of the celestial movements. The publication of the translation of Ptolemy's *Geography* into Latin in the 1470s and into Greek by Erasmus in 1533 inaugurated a mathematical revolution, as geometry could be applied to surfaces to find ways to represent space. The old cosmography based on biblical and classical comprehensions of the world was being superseded by mathematically precise geographical representations of the entire globe according to the 'logic of the grid' (Vogel 2006, 469; Jones 2019, 98). Cosmographers combined the theoretical and applied aspects of mathematics to rule the terrestrial world: the known world could be measured and mastered (figure 2). Cuningham argued that

> the whole face of th'Earth … [can be] drawne two sundry waies: either on à roūd plate forme, for which inuention the Globe moste aptlye serueth: or els on à plaine plat forme, as à Card in which we drawe th'vniuer sall Earth, or els but the half, or the one part: yea, & you please but one particuler Region: which is proper to Chorographie (as I said to you in the first booke [)]. … Th'inuention should seme much better to drawe th'Earth in à playne plate fourme, theron à Globe, for in it, we maye behoulde the whole face of th'Earthe … I wyll accōplish your desire, in describinge à perticuler Regiō, Countrey, or Prouince, Firste you shall drawe à right line in such length (in the middes of you parchement, or paper) as it will aptly receiue. This line shall represent the meridiā Line for the middes of that Regiō. Then diuide this line into so many equal portiōs, as the latitude of the regiō is: drawynge right Lines, or paralleles, in euery of the same diuisiōs, according to the capacitie of the plat forme of thy paper, or parchement. (*CG*, 114-115, 116)


COSMOGRAPHICAL GLAS. Fol. 7.

Chorographie, sheweth the partes of th'earth, diuided in themselues. And seuerally describeth, the portes, Riuers Hauens, Fluddes, Hilles, Moūtaynes, Cities, Villages, Buildinges, Fortresses, Walles, yea and euery particuler thing, in that parte conteined. And is in respect saith he, of Cosmographie and Geographie, as if a pāter should set forth the eye, or eare of a man, and not the whole body, so that Chorographie consisteth rather in describyng the qualitie and figure, then the bignes, and quantitie of any thinge.

Spoud. *Although by your wordes, I haue receiued more commoditie at this present, then by all my readyng touching the true diference of these three names: yet if it may please you to geue me the figures of euery of them, I shall so stedfastly printe it in my mynde, as I truste not to forget them, for it is truly said, thinges sene haue longer impresion then only harde.* Thinges seene are longer in mynde, then only harde.

Philo. *I wyll gladly fulfill your requeste. Marke nowe this example following. Here firste you do see the heauens conteine in them th'earth. Whiche earth is deuided into fiue principall partes, accordinge to the fiue Circles in the heauens: the names of whiche for breuitie I omytte vntyll conuenient place, lest thorowe ofte repeting things thei at length seme tedious. The other*

¶ This figure representh the forme of Cosmographie.

Figure 2 – The Forme of Cosmographie, 7. By permission of the British Library

To draw the whole face of the world, Cuningham relied on grid delineators as the equinoctial line, the meridian, the tropic and polar circles, and the lines of longitude and latitude, providing tables and practical ways of finding out the meridian with an astrolabe, with a table of the sun's meridian or with the use of a cross-staff (*CG*, 137, 88 and 62). Within the visual space of the engraving, Spoudaeus and Philonicus can follow Ptolemy's method (figure 3). Because the sciences of mathematics, cosmography and astronomy bore directly on maritime navigation, his method could also be used by the navigators who could calculate

the latitude of the place by findinge the height of the Northe starre, which they call the lode starre, esteming à degre, or two, in obseruation as no error. But you shall worcke in thys maner: first find out any notable starre (that you knowe perfaitly) in the table of fixed starres, & with Ptolomaeus rule, or other instrumente, obserue his heighte in the meridian line: then in the table of declination, you shall find how much he declineth North or South, from th'equinoctiall, & obseruing th'order, as you do with the searching out of the Pole by the sonnes altitude Meridiane, and declination. (96)

Figure 3 – Untitled, 88. By permission of the British Library

As eclipses were a possible practical way of finding longitude, Cuningham inserted a table of eclipses which he had calculated for the fifty years following the publication of *The Cosmographical Glasse*, from March 1560 to September 1605. Also included were a table of the ebbs and flow 'in the Coastes of Englande, Scotlande, Irelande, Duchelande, and Fraunce', and the correction of Jofrancus Offusius' 'errors in the [merueilous] needle [that] turne[s] alwaye to the North pole' (98-102, 152 and 161). Cuningham provided some information too on clocks 'such as are brought from Flaūders, & we haue thē as excellently without Temple barre, made of our countrymen' (110).

Cuningham provided instructions on how to make a map of England by use of parallel intersection lines with a grid showing global coordinates. The scope could be widened to

> drawe à Carde for Spaine, Fraunce, Germany, Italye, Graece, or any perticuler regiō: yea, in à warme & pleasaunt house, without any perill of the raging Seas: danger of enemies: losse of time: spending of substaunce: werines of body, or anguishe of minde. Oh how precious â Iewell is this, it may rightly be called à Cosmographicall Glasse, in which we may beholde the diuersitie of countries: natures of people, & innumerable formes of Beastes, Foules, Fishes, Trees, Frutes, Stremes, & Meatalles. (120)

These practical methods not only conceptualized the Earth's surface and attempted to forecast the nature of the unknown, they connected the accidental world of the senses with the mathematical perception of the world (Livingstone 1990, 79). Mathematical cosmography provided a verbal, visual and scientific representation of chronologically and geographically remote spaces, places that could never be fully grasped by the naked eye alone. The visual dimension of knowledge was also transcribed with the glass metaphor that became a cosmographical commonplace as testified by the titles of works as William Caxton's *Myrrour: [and] dyscrypcyon of the worlde with many meruaylles* (1481), or by the device *Speculum cosmographiae* developed in *Cosmographicus Liber* by Peter Apian (Dekker 2002, 32). Unsurprisingly, Cuningham 'deuised this mirrour [in] which, mē may behold not one or two personages, but the heauens with her planets and starres, th'Earthe with her beautifull Regions, and the Seas with her merueilous increase' (*CG*, Aiiv). More than projecting the visual image of a multifaceted universe with the mirroring of earthly and astronomical knowledge, the glass metaphor turned out to be a pragmatic instrument of scientific inquiry that revealed things as they were (Grabes 1982, 4-39). John Gillies argued that Cuningham's glass was more than a simple mirror. It was in fact a 'curved mirror like a "Claude Glass" (the latter-seventeenth-century aid to landscape painting)' that was used 'to shrink that object, to reduce it to a manageable scale' (1994, 92). The glass thus relates to perspective, to the miniaturisation of the universe that could be better grasped and controlled by a hypothetical seeing for oneself or autopsy. Robert Recorde's *Pathway to Knowledge* gives us yet another interpretation. Recorde alludes to 'Fryer Bakon' who made a glass 'in whiche men myght see thynges that were doon in other places' (Preface, iijv). In his 1267 *Opus Majus* that was not printed until 1733, Roger Bacon indeed discussed glasses (lenses), claiming it was possible to shape 'transparent bodies and arrange them in such a way with respect to our sight and objects of vision' that 'from the incredible distance we might read the smallest letters and number the smallest particles of dust and sand' (Wilson 2020, 73). Glasses contracted, magnified and extended the range of vision beyond the normal and natural; they also corrected humans' defective sight. As Relihan contends though, the imperfect quality of mirrors in the early modern period simultaneously mingled the scientific experience of the universe with an inaccurate sensory perception (2004, 12-13).

4. *To Find Out the Path*

Cuningham insists the 'foule, & vglie beast Ignorance' (*CG*, 143) whose 'bondes, and chaynes' (2) could only be shaken off with 'all possible meanes, to imbrace Sciẽce & Cunning' (143). His purpose was to impart as much information as possible to his reader. In addition to geography and chorography, he also wished 'to make [his work] an Astronomical Glasse' to depict 'the Type of the world' (Aiir and 51). The full-page woodcut of 'Coelifer Atlas' that concludes Book I and that reveals his conception of the universe is an epitome of Aristotelian and Ptolemaic cosmology (figure 4): the sublunary sphere is composed of four elements whereas the heavens consist of concentric spheres including seven planetary spheres, the fixed stars, and the primum mobile whose motion revolves around the earth (50). Atlas, the bearer of the armillary sphere, has a hybrid character: he is dressed like an ancient character with his long skirts belted at the waist, and wears a crown (Cuningham wrongly believed that 'Ptolemaeus, Atlas and Alphonsus [were] kinges' 2), but he also was a Titan, Prometheus' son, who had been punished and condemned by Zeus to carry the world on his shoulders. Knowledge, imperfect as it might be, came at a price.

Figure 4 – Untitled, 50. By permission of the British Library

As Chen-Morris argued, the senses' inherent limitations were particularly perceptible in the study of heavenly phenomena as heavenly bodies were far too remote to supply a human observer with direct and reliable knowledge. The existence of 'an epistemological barrier that divides what is immediately given and can be fully known and what is distant and beyond human perception' entailed that any knowledge concerning the cosmos must be speculative (2016, 257-258). For Cuningham Icarus' fate symbolised the acute awareness of the limits of human knowledge: Daedalus' son paid the price for soaring into the stars and getting closer to God. *The Cosmographical Glasse* opens with the figure of Daedalus,

> that excellent Geometrician … [who] whan as with the eyes of knowledge, he did beholde that horrible Mõster Ignorãce … [devised] how to banish hir his praesence and companye: or els by what meanes to escape, oute of her lothsome Labyrinthe … he praepared winges (throughe Science aide) and so did flye oute of hir mooste filthy Prison. … *He made him winges wher with to flie: / Ascending to the Sterrye Skie*. (Aiir)

In his dedicatory epistle to Robert Dudley, Cuningham echoed Erasmus' introduction to the Greek edition of Ptolemy's *Geography* in which the humanist praised Ptolemy 'with whose guidance man can easily find his way out of this labyrinth' (quoted in Vogel 2006, 469). Cuningham promised to place his patron and readers above the mundane to enable them to better master obstacles and overcome ignorance, which was a manifestation of the 'Euclidean ecstasy' that infused early modern scientific culture from the sixteenth century onward (Cosgrove 1992). This elevated perspective, implying a god-like, impossibly high vantage point, is manifest in Cuningham's bird's-eye view map of Norwich in which two figures – probably Spoudaeus and Philonicus – stand upon a foregrounded hill and are engaged in viewing the details of the city (*CG*, n.p.). Philonicus, the teacher/author and Spoudaeus, the pupil/reader occupy more than once the pictorial space (1, 88 and 111) which both points at the constructed nature of the space they inhabit and their presence performing the reality of going out on the field to make observations and reckonings.

The geographer/cosmographer thus has 'to finde out the pathe … [where] to treade' (Aviv) between the old and new perceptions of the cosmos and to delineate the epistemological boundaries he was not willing to cross. Like many other early modern cosmographers Cuningham was typical in his reverence for authority. He did not look favourably upon new theories. Were not the ancients unquestionably superior to the contemporaries? 'how many sondry Artes, secrete Sciences, and wonderfull Ingens, throwgh well spending of tyme', he explains, 'did the auncient Philosophers in their dayes inuente?' (2). He was thus 'not worthy to kisse [Ptolemy's] fotesteppes, aswell for the majestie of his person, whan he lived, as also for his excellent Learning, Science, & diligence' (169r). Old geocentric theory of the universe held virtually undisputed sway over Renaissance England and Cuningham feared to tread in 'a field pre-empted by ancients' (Foster Jones 1982, 11). Rejecting the Copernican theories, he condemned 'those that will not haue [the Earth] to be the Center of the heauen. Those that suppose the Earth to moue' (*CG*, 44). As many other cosmographers he did not accept Copernicus' system but was not averse to using his observational data and calculations.[6] There were however 'matters of great difficultie', 'muche vntruthe' and 'repugnancie betwixt [some ancients'] authoritie, & dayly experience' (*CG*, 3 and 145). Sometimes putting 'reason, & experience' above tradition Cuningham corrected Polybius, amongst others, and the number

[6] 'I do not use the blind tables of Alfonce, … but Copernicus, and that famous Astrenomer Erasmus Reignholt, [who should be] reputed for yonge Ptolomaeus' (1558, Aiiv).

of zones as well as Ptolemy's calculation of latitude (159, 65 and 62), but offered at the same time excuses for their errors:

[Ptolemy] was not able being so mighty à Prince to trauell into those countris, that to à priuate person (for the greate distaunce à sunder) was impossible. And therfore receiuinge (as he confesseth) obseruations at other mens handes, dyd in many sundry places swarue from the trueth … And that was not to be imputed vnto Ptolomaeus as à crime, seyng the errour ensued by other mens obseruations. (118)

The biblical heritage was not challenged though (figure 5). Since cosmography 'confesse[d] th'omnipotency, and wonderous worke of God' (Aiiiv), it shed light on many passages of the Bible, such as the Biblical winds, the division of the Earth – Japhat, one of Noah's son, had settled in Cyprus – or the location of heaven and hell (198). Classically-trained Cuningham inferred that hell

must nedes be in the center of th' Earih … for that is of all other parts furdest from the heauen. Whych is the cause that not onlye we, but also the Poëts in their tragedies, introduce persons comming out from vnder th' earth & call that place Hell, amonge other, Senica introduceth … (82)

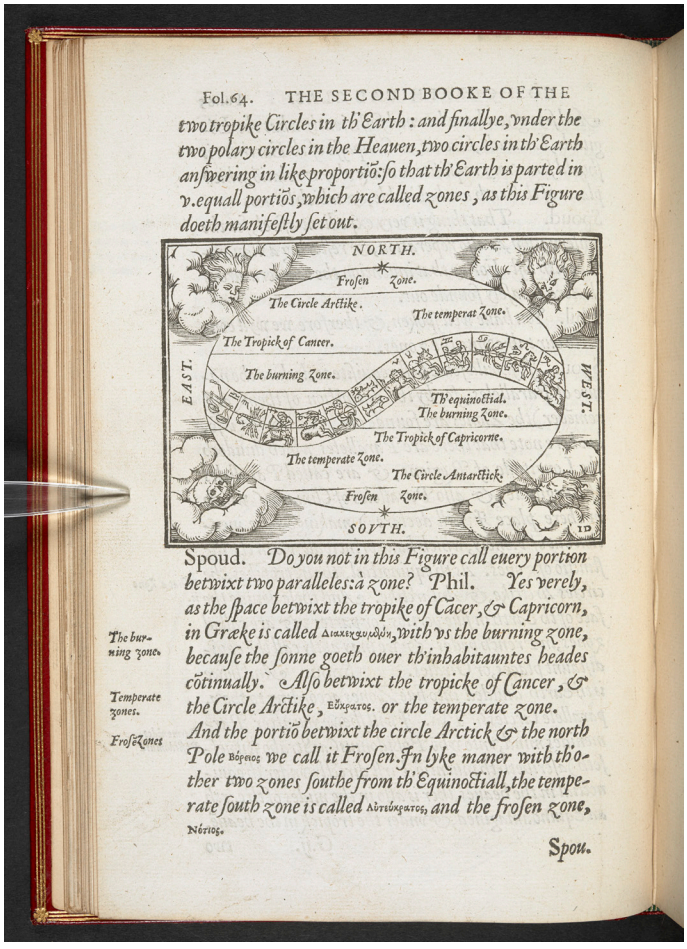


Figure 5 – Untitled, 64. By permission of the British Library

There was also no questioning of the belief that every region of the globe was governed by certain planets and 'signes' that determined the major influence to which the inhabitants were subjected (133-135). Livingstone underlines though that to speak of 'pre-modern' and 'modern' sources of knowledge does not make much sense: in the early modern period 'the notion of any conceptual bifurcation between the magical and the scientific was a distinction without a difference' (1990, 361-362).

There was one branch of knowledge that blatantly revealed the ancients' insufficiencies and modern superiority and it was geography. Early modern cosmographers were better informed than their predecessors owing to the development of printing. They also lived in an age of explorations that witnessed the expansion in geographical learning with the innumerable voyages and the accumulation of empirical data. The oceanic discoveries between Vasco da Gama's rounding the Cape of Good Hope and Ferdinand Magellan's circumnavigation had an impact on the conception of the globe, 'revealing a larger, more watery, and more geographically diverse globe than Aristotle had theorized or Ptolemy had described' (Cosgrove 2007, 59). By the 1530s, European scholars knew that oceans could be navigated and that all parts of the newly discovered lands were inhabitable. This gradual realization reinforced the need for a conceptual framework that would maintain the balance and symmetry of the Aristotelian elements, and make sense of recent geographical findings in relation to ancient authorities (Davis 2011, 531). The balance was difficult to maintain and sometimes it was necessary to differ from antiquity. A case in point is the old theory according to which the burned or torrid zone was uninhabitable. By the 1550s, English explorers had crossed the torrid zone, and seen for themselves that these regions beyond the *oikoumene* were both inhabitable and inhabited. Cunigham did not fail to record this new perception.

> Moreouer the Nauigatiō to Calicute, (of which voiage Vesputius, & Columbus were the first authors, & nowe more frequented of the spanierdes, then sayling into coūtreis nie adiacēt to vs) do witnes beare, that vnder this burning Zone there are inhabitaūtes … by these wordes it is manifest, that the burning Zone is not habitable onely, but also inhabited. (*CG*, 67)

European navigators had discovered Calicut in India or the Moluccas archipelago in Indonesian but as indicated in the above quotation, Cuningham was rather confused about the recent discoveries, attributing the navigation to Calicut to Vespucci and Columbus. Despite his apparently knowledgeable comment, Cuningham's information was quite sketchy: 'I may seme to vtter that all men know, in making rehersall of th' Indians, Calicute, Ginea, the. v. Ilandes Moluccae, also Porne, Sololi, & infinite other, which are the frutes of Cosmographie in this our age' (Avv). In the fifth and last book, the shortest portion of *The Cosmographical Glasse*, Cuningham engaged in a description of the location and description of particular regions, starting with Europe, to then focus on Africa, Asia and America,

> whiche is named the fourth parte, & was to Ptolomaeus, & th' Auncient Geographers vnknowē: as also at this praesent great part of it is not yet foūd out. It taketh the name of America, of Americus Uesputius, who by the cōmaundement of Ferdinando king of Castell, founde it out, in the yeare of Christ oure Sauiour. 1497. aboute th' ende of Iune, as doeth appeare by his owne testimonie. (200)

Cuningham devotes two and a half pages only to America, whose ontological status is unstable (in his mind, it was both a continent and an island), and comprising Peru and Hispaniola, with Brazil listed as one of a number of islands while Yucatan, Cuba and Jamaica become Asian islands associated with the Moluccas (113, 199 and 201). Though descriptions of Peru

had been circulating in Europe since the publication of Hernán Cortés' letters describing the conquest of Mexico printed in Nuremberg in 1524 and Cologne in 1532, some authors, Cunigham included, could not update their cosmography due to the paucity of the information they had (Davis 2011, 361). Cuningham could rely on his own observations or his friends' to describe England and Europe, but his approach to the geography of the New World was bookish (Fuller 2013, 23).

Separating geographical fiction from geographical fact was not as yet relevant though. From 1499, John Mandeville's *Travels* had been a chief source for the circulation of older information about the geographical and ethnographic marvels lying beyond the boundaries of Europe. Even geographers who were truly intent on representing the world as accurately as they could include persisting myths from the Middle Ages either in maps or narratives. Cuningham was not immune from this fascination with the strange and marvellous inherited from Pliny. His work includes nine historiated initials of the same size (63 mm). Given the correspondence in each case between the historiation and the subject of the chapter it introduces, they seem to have been nonce capitals (Edwards 2008; Blayney 2019). The historiated capital W opens the fifth book's section 'Of Asia the thirde Parte of th'Earth' that addresses Asia's inhabitants the 'Pygmeans' (*CG*, 190). The engraving is divided between a long-necked bird (top left corner) and diminutive human figures astride sheep directing their spears at the bird (bottom right corner). The battle between pygmies and cranes was taken from Pliny's *Natural History* (1969, VII, ii, 26).

Contemporary information on the New World was spread by Richard Eden's *A Treatise of the New India*, printed in 1553, and followed up in 1555 by his translation of Peter Martyr's *Decades of the New World*, a source of inspiration for Cuningham:

> And therefore suche as trauayle throughe the same, haue nede to take great hede … because there are heard voyces of deuyls, calling them that wander alone, by theyr proper names, conterfeyting the voyces of theyr companie that goeth beefore, by this meanes withdrawing them from the right waye, and bringinge them to destruccion. There is often tymes heard in the ayre, as it were a noyse of musicall instruments. (1885, 27)

> The spirites in this coūtrie, by many illusions seke to bringe trauailers into daungers, sumtime by calling them by theyr names, other times by musicall noise, as it were alluringe thē by the swetnes of the sounde, vntil they be brought into danger through wilde beastes. (*CG*, 190)

Eden's *Decades* printed accounts of the first two English voyages to sub-Saharan Africa and interpolated into them sections about uncanny creatures. As mistrustful as he may have been, Cuningham still presented a version of Africa which suggested that at the edge of the *oikemene* lurked monstrous creatures displaying morphological aberrations or indulging in horrific cultural practices:

> The people blacke, Sauage, Monstrous, & rude: yet in those countries, cities, & townes where the Spaniardes, Portugalles, Italians, & other do frequent, the people are sumwhat more ciuill, modest, & reasonable. Diuers also (yea right graue authors) make mētion of certaine deformed that dwell in Africk, as men with dogges heades, called Cynocephali, some with one eye & that in the forehead, named Monoculi, others without heades, & theyr face in the breast, with diuers such like which I suppose rather fables then any truth. (186)

> Th'inhabitauntes [Pygmies] are sundrye, & diuers: for some are Anthropophagi, which eate the flesh of men: & drinke their bloud. (190)

In the fifth book like a gazetteer of a sort, Cuningham lists topographical details of most of the then known countries of Europe and Asia, including Thibet and Cathay, and a few ethnographic and economic elements about the incredible wealth abounding in the newly-discovered spaces. These lands of plenty were found out 'to the great benefites of all Europe' (Avr-v). In *The Cosmographical Glasse*, Cuningham intended to profit '[him] selfe, & also [his] natiue country' (112). In his praise of the art of cosmography, he emphasised that with its knowledge, 'the famous marchaunts, haue by it not onlye inriched them selues, but also their country … [while] mariners & trauailers on the seas (without which no realme can long stand, or mans life be sustaind)' could take stock of the world as it was then perceived (Avr-v). But Cuningham had not yet fathomed how the discoveries could serve the grandeur and economy of the fledgling Elizabethan regime and of early modern England.

Cuningham's purpose was to bring some of the latest European discoveries to his readers outside intellectual and university circles. In his attempt to instruct but also to maintain dreams of unity and harmony, he had amassed volumes of data and synthesized them (Cosgrove 2007, 98). *The Cosmographical Glasse* perfectly illustrates the tensions between traditional sources and recent discoveries, received anecdotes and observation-based geography in its attempt to marry mathematics and marvels. New continents being empty spaces open to imagination, in his depiction of areas of enormous magnitude, Cunigham adopted a synoptic god-like perspective, which positions the reader/viewer out of and above space, a perspective that implied a kind of possession and the imagined conquest of space (Gillies 1994, 92; Chen-Morris 2016, 258). 'Paper theatres of the world', maps mastered, reified and colonized space, but they also spatialised knowledge, marking the operations from which they resulted. They were perfect embodiments of the tensions inhering in early modern cosmography in their juxtaposing of heterogeneous data furnished by tradition and those coming from navigators, forming 'the tableau of a "state" of geographical knowledge … a place in which to exhibit the products of knowledge from tables of legible results' (De Certeau 2011, 119-121). If *The Cosmographical Glasse* does not meet our modern scientific requirements, it surely had some scientific merit for Cuningham's contemporaries. William Bullein's 1562 'A little Dialogue, betwene twoo men' praised 'worthie persones, and cunning men, profitable to our common wealthe' who were in the vanguard of advancing knowledge. To this category belonged Andrew Borde, Robert Recorde, William Turner and 'Doctor William Kunyngham' who contributed much to the dissemination of knowledge, having 'well trauailed, like a good soldiour, against the ignoraunt enemie: setting forthe the commendaciõ praise, and profite of Astronomie, Cosmographie, and Geographe' (Aaiiii).

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