Articles

Newton, The Newtonians, and the *Geographia Generalis Varenii**

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Abstract. Editions of *Geographia Generalis* (1650, 1664 and 1671) by Bernhard Varen and successive Cambridge Latin editions of Varenius's work by Isaac Newton (1672 and 1681) and James Jurin (1712) are used to relate their contributions in geography to the broader scientific and intellectual ferment of the late seventeenth and early eighteenth centuries. Aside from illustrating conflicts in the transition from the Cartesian to the Newtonian tradition, these successive editions and the original correspondence of their authors are used to identify the central importance of geography in the curricula of selected English universities and the substantial original contributions to geography by Isaac Newton in particular, but also by Edmond Halley and James Jurin.

Key Words: geography, Newtonian-Cartesian controversy, *Geographia Generalis*, history of geographic thought, 17th and 18th-century European science, Isaac Newton, Edmond Halley, James Jurin, Roger Cotes, Richard Bentley.

A significant aspect of the flawed final work of Bernhard Varen (1650) was its unequivocal refutation of the Aristotelian-Scholastic conception of Geography and its enthusiastic acceptance and application of Cartesian philosophy and science. Endorsed by the Cambridge Platonists, the work was twice edited, emended, and enlarged by Isaac Newton (1672 and 1681), albeit in a cautious and conservative way respecting René Descartes, but in the frame of reference of the Lucasian Professorship of Mathematics and Natural Philosophy.

In 1712, under the aegis of Richard Bentley, Master of Trinity College, Cambridge University, now controlling the University Press and using it to assail and discomfit his many adversaries and detractors as well as to foster excellence in research and scholarship and to disseminate the results, the *Geographia Generalis Varenii* underwent further significant revision. The committed young Newtonian, James Jurin (referred to in some sources as Jacob Jurin) bore the responsibility for editing the new edition with help from Roger Cotes, Edmond Halley, and others.

The clever scheme used by Samuel Clarke (1675–1729) in presenting Newtonian science in his edition of Rohault's *Physica* (1710) while still retaining its original Cartesian offerings was

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used by Jurin, for the same reasons, to preserve the original Cartesian and to present the newer Newtonian geographies in parallel. [*Editor's Note: Descartes and the Cartesians were respected by Newton for their "method" of science, concern for motion, and application of mathematics. However, the Newtonians advocated strictly empirical and experimental bases for the validation of findings. They opposed the subjectiveness of Descartes's rational approach and the rigid mechanical explanation for the nature of matter. Whereas Descartes sought to identify causes of motion, Newton was concerned more with measurable effects. Debates on the merits of these and related views constitute the Newtonian-Cartesian controversy. Incorporation of a Newtonian perspective in the revisions of Varenius's work illustrates the importance of the* Geographia Generalis *and its Cambridge editions for monitoring intellectual ferment during the Scientific Revolution (c. 1550 A.D.–1700 A.D.) and for directing the development of modern Geography. dgj*]

In 1733 Dugdale and Shaw provided an English translation of the Jurin edition and furthered the cause of Newtonian science by incorporating additional empirical findings achieved in the interim. Three further editions of Dugdale and Shaw as well as certain derivative works portraying the "Newtonian Philosophy and Geography" followed and helped to establish patterns in geographic thought and practices not only in the two English universities but, significantly, also in the American colonial colleges (Warntz 1981). The context to this development is seen not only in the correspondence and associations of Cotes, Halley, and Jurin, but also in the geographical and intellectual context of Varenius's work, and in the original contributions of Isaac Newton.

The Newtonians and the General Geography of Bernhardus Varenius

On or about 20 January 1710/11, Roger Cotes (1682–1716), Fellow of Trinity College, University of Cambridge, and the recently appointed Plumian Professor of Astronomy and Experimental Philosophy[1] in that university, dispatched the following letter (Cotes 1710/11, 204–205)[2] to Edmond Halley (1656–1742), then Savilian Professor of Geometry, at the University of Oxford:

> S^{r}.
>
> Tis now about two Yeares since I wrote to You, in behalf of M^{r} Jurin a Fellow of our College, to desire y^{t} he might have Your leave to annex some of Y^{r} Treatises to his Edition of Varenius's Geography. You was pleased to consent to it & promise some additional improvements & besides a new Treatise concerning Coelestial Refractions. I hope You have lately received a Letter from him to remind You of Y^{r} promise, & to desire y^{t} a freind of his may wait upon You for Y^{r} Papers as soon as you shall have leisure to finish 'em. He further desires if any new Figures must be inserted or any alterations made to y^{e} old ones y^{t} You will be pleased to send them first & y^{t} You will be so kind as to send him word what he had best do with y^{e} Map of y^{e} Trade Winds & Variations [of the Compass] & whether He may take that in the Miscellanea Curiosa with the English names as they stand there. The greater part of Varenius is already printed off, we do therefore beg of You to finish Y^{r} Papers as soon as You have convenient leasure. I beg Your pardon for the trouble I give You.
>
> I am S^{r}
> Y^{r} much Obliged & Humble Serv^{t}
> ROGER COTES.

The Mr. Jurin (1684–1750), Fellow of Trinity College, mentioned above, was James Jurin, Master of Newcastle-on-Tyne Grammar School. Later he became Fellow and then Secretary of the Royal Society as well. Subsequently he was recognized as perhaps one of the most learned men and the most distinguished, although controversial, physician of his age. After a lifetime of international celebrity, deriving from organizing or participating in a wide variety of scientific activities, Jurin's career was capped by his election as President of the College of Physicians, London, in 1750, a few weeks before his death. Throughout, Jurin was a dedicated "Newtonian" as were his mentor, Richard Bentley, and his active and would-be assistants, Roger Cotes and Edmond Halley, respectively. Needless to say these "assistants" were engaged with other things as well at this time.

Cotes, in his all-too-brief scientific career, attracted wide acclaim and early election as Fellow of the Royal Society. Modern scholars of the history of science of the seventeenth century seem to be particularly fond of citing the observation of Isaac Newton (1642–1727), "Had Cotes lived, we might have known something!" Cotes is best remembered for his own very re-

markable and substantial contributions as editor of the second edition of Newton's "Principia" (Cotes 1713).

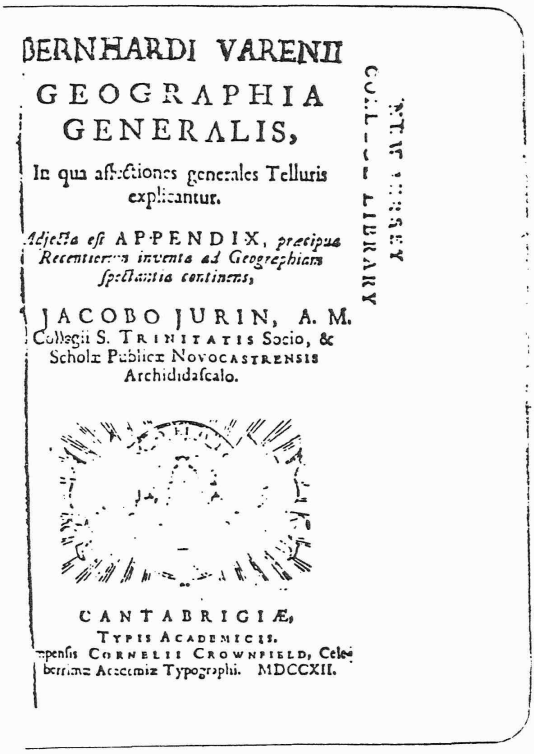
Cotes's perscrutation and perspicacity combined with forbearance, patience, and a willingness to undertake tedious tasks, in connection with "cooperating" with Isaac Newton in bringing forth the second edition of the "Principia," have been so well documented by such modern scholars as D. T. Whiteside (1967–81), I. B. Cohen (1971), and R. Westfall (1980), for example, that little need be added here. So, too, with the life and accomplishments of Edmond Halley, documented by Ronan (1969) and by Thrower's (1978) account of Halley's lifelong geographical and cartographical concerns.

How the generally most affable and cooperative, although in this instance dilatory, Halley, ultimately, though tardily and only partially, did respond to the several supplications and reminders of Jurin and Cotes after a period of two years will be evidenced subsequently in an examination of Jurin's edition of *The General Geography of Bernhardus Varenius* (see Fig. 1).

Appreciation among geographers for the life and work of Varenius was enhanced greatly by Baker (1955), and Bowen (1981) and May (1983) have illustrated how geographical writings of the period relate to broader philosophical debates of the seventeenth and eighteenth centuries. To this day, however, the editions of *Geographia Generalis Varenii* by Jurin and by Isaac Newton are known and appreciated only in such an esoteric fashion that it is felt necessary to provide some discussion of them in detail.

Jurin's Latin edition of the *Geographia Generalis Varenii* was really the third such edition from Cambridge. While active as the Lucasian Professor of Mathematics and Natural Philosophy in accordance with opportunities and responsibilities under the statutes of that professorship, Isaac Newton had twice revised the work himself—the first time in 1672, shortly after his appointment in 1669 as the second incumbent of the Lucasian Professorship, and the second time in 1681, five years before the completion (six before the publication) of the "Principia."

At the time when the second Latin edition of the "Principia" and the third Cambridge Latin edition of *Geographia Generalis Varenii* were being prepared, Newton had long since departed Cambridge, had belatedly resigned from


BERNHARDI VARENII

GEOGRAPHIA GENERALIS,

In qua affectiones generales Telluris explicantur.

Adjecta eſt APPENDIX, *præcipua Recentiorum inventa ad Geographiam ſpectantia continens,*

JACOBO JURIN, A. M. Collegii S. TRINITATIS Socio, & Scholæ Publicæ NOVOCASTRENSIS Archididaſcalo.

CANTABRIGIÆ, TYPIS ACADEMICIS. Impenſis CORNELII CROWNFIELD, Celeberrimæ Academiæ Typographi. MDCCXII.

Figure 1. Title page of James Jurin's edition of the *Geographia Generalis*. The translation follows: THE GENERAL GEOGRAPHY OF BERNHARDUS VARENIUS. In which the general affections of the Earth are explained. *An APPENDIX has been added, containing the excellent observations added to Geography of the Modern Authors,* by JAMES JURIN, M.A. FELLOW OF TRINITY College, and Headmaster of NEWCASTLE [on Tyne] Public School. University Press of CAMBRIDGE. Published by CORNELIUS CROWNFIELD, Printer of the Most Famous University. 1712.

the full profits of the Lucasian chair, and presumably was enjoying something of life in London, as Sir Isaac, President of the Royal Society, at least in so far as his quarrels and bickerings with Flamstead and Leibniz would permit.

Although the Newtonian-Cartesian controversy at Cambridge University in 1712 dominated all else in science there, the persistence of a by no means inconsequential Aristotelean scholastic contingent in the university is not to be ignored. In fact, it was the Scholastic-Cartesian debate that initially inspired the student, Bernard Varen (1622–50), and helped to shape in his mind the modern intellectual thrust that his studies and writings were to take. A brief

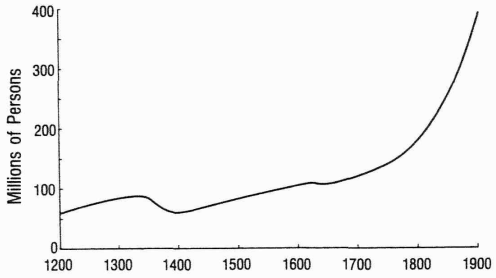


Figure 2. The population of Europe 1200 A.D.–1900 A.D. The accelerated growth after *c.* 1750 is in large measure a result of scientific achievements in the seventeenth and early eighteenth centuries. Editor's note: The author's documentation of data sources and analyses for this graph and for Figures 3–9 are available for investigation by scholars in the Warntz Collection of the Regional Science Archives, Cornell University, Ithaca, New York.

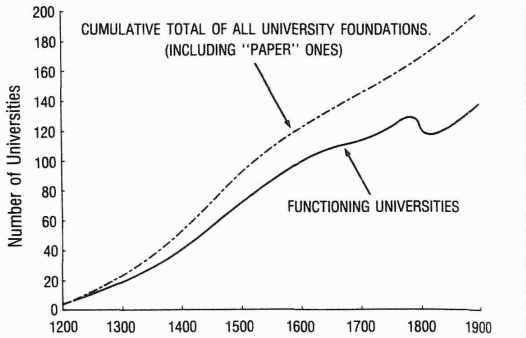


Figure 3. Number of universities in Europe 1200 A.D.–1900 A.D. A distinction is drawn between the number of operating universities and the number of universities that were founded.

examination is needed of the original *Geographia Generalis* (Varenius 1650).

A Note on the Historical Setting

Before considering the endeavors of Varenius, the time, 1650, and the place, Amsterdam, must be seen in general historical context. While the concern of this paper is simply a textbook compiled by a despairing and soon to be deceased twenty-eight-year-old scholar, the *Geographia Generalis Varenii* in its initial edition, and subsequent ones by others, mirrored the struggles in philosophy and science of that age and was after all an element, although perhaps only a minor one, in the lives of many of the luminaries of those times.

See now Figures 2–4. These represent certain aggregate time series values concerning European populations, 1200 A.D.–1900 A.D., and the origins and geographical spread of universities and of printing by moveable type.[3] As such they direct attention to the substantial intellectual precedents and contemporary importance of knowledge in the lifetimes of Varenius, Newton, and the Newtonians. Particularly does this seem so with respect to Figure 5, conveying the information that neither before the mid-seventeenth century nor again until the post-World War II era of twentieth-century Europe were there so many universities relative to the population of Europe. (This refers to the number of universities and does not consider the size of enrollments.)

In Figure 6, data from the preceding graphs are incorporated into one diagram but this time as a semi-logarithmic graph. The triple intersection of the three curves, *c.* 1650, is, in a sense, contrived because of the arbitrary nature of selection of units for the scaling of the three phenomena. But since the three vertical scales all *are* logarithmic, growth rates (or rather rates of change) all *are* comparable and can be judged, to a first approximation, simply by visual inspection. It is important to note that in each of the three instances considered, overall growth which had been occurring, albeit at declining rates, up to mid-seventeenth century, now began anew at increasing rates for each but with substantially different relative importance. The end of one epoch (Renaissance?) and the beginning of another (Modern?), each with its own set of logistic curves,[4] conveniently might be considered as having their transition at mid-seventeenth century—to the extent that such a fixing of dates for "epochs of history" have meaning at all. Nevertheless the graph in Figure 6 displays the added intellectual bonus of a marvelous mnemonic device (so beloved by students *and* their professors) for that year, 1650, when the Aristotelean Scholastics-Cartesian debate peaked and the Newtonian-Cartesian controversy was in the offing, and the original *Geographica Generalis* of Bernhardus Varenius was published. There existed then in Europe

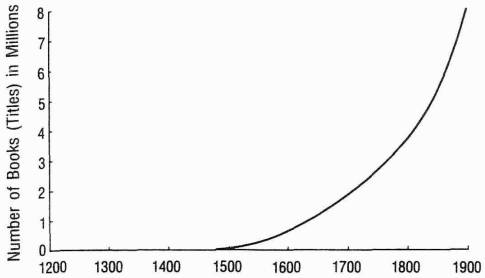


Figure 4. Number of printed books (titles) published in Europe. Cumulative total from 1200 A.D.–1900 A.D.

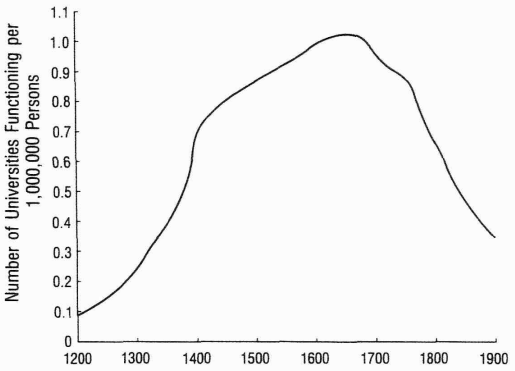


Figure 5. The number of universities relative to the population of Europe 1200 A.D.–1900 A.D. peaked in the mid-seventeenth century.

approximately *one hundred* universities, *one million* printed books (titles), and *one hundred million* persons.

The spatial distribution of the time series phenomena shown in Figures 2–6 underwent substantial and varied changes as well. Figures 7–9 show changing geographical patterns of population distributions as maps of "Potentials of Population" for 1200 A.D., 1500 A.D., and 1700 A.D. Potentials of population represent the accessibility of places to the aggregate influences of populations for all places. Thus, the population potential at a point, say London, is a function of the populations of all other places in Europe and the reciprocals of their distances from London. Calculations for a large number of places in Europe allow for a generalized pattern of accessibility, mapped as a continuous surface as lines of equipotentials of population. The high and low values of Figures 7–9 reflect the potentials for interaction of places with other locations. Discussions on the computation and execution of such maps and on the conceptual basis of population potential are found in Stewart and Warntz (1968) and Warntz (1979). [*Editor's note: For purposes of this discussion, the maps illustrate the ascendancy of the focal points associated with the* Geographia Generalis *(Amsterdam and London) and of other places of concern to the history of seventeenth-century science and technology.*]

The *Geographia Generalis Varenii*—First Edition

Consider the *Geographia Generalis Varenii* by examining the title page of the 1650 publication of the Amsterdam branch of the celebrated Elsevier publishing house (Fig. 10). Does this engraved title page actually show Varenius? According to Gottfried Lange (1961), it does. He has argued that the young man in the foreground, obviously from his attire, is a university graduate, namely Varenius himself. The two older gentlemen, to whom Varenius is offering whatever explanation it is, were identified by Lange (from a consideration of amulets and regalia) as two of the Mayors of Amsterdam, namely Klaes Corver and Ridder Dr. Cocq, included in the list of worthies in the "Epistola Dedicatoria" of Varenius. These were men of affairs and influence whose patronage the nearly destitute Varenius eagerly sought. Such a portrayal could be considered as yet another vanity portrait. (It is of some interest to note that Banning Cocq also was the central figure portrayed in Rembrandt's "Night Watch" [1642], more appropriately titled "The Shooting Company of Captain Fr. B. Cocq Just Before Marching Out.")

On the other hand, Lebed'ev (1950) has identified the individuals as Copernicus, Tycho Brahe, and Ptolemy. This may seem uncertain, however, given the content of the book, but the general iconographic practices of the seventeenth century would suggest it. Lange held the opinion that Lebed'ev had confused the Varenius work with that of Christiani's 1645 works on Geography and Astronomy[5] in the latter of which the merits of the systems of Ptolemy, Brahe, and Copernicus were analyzed.

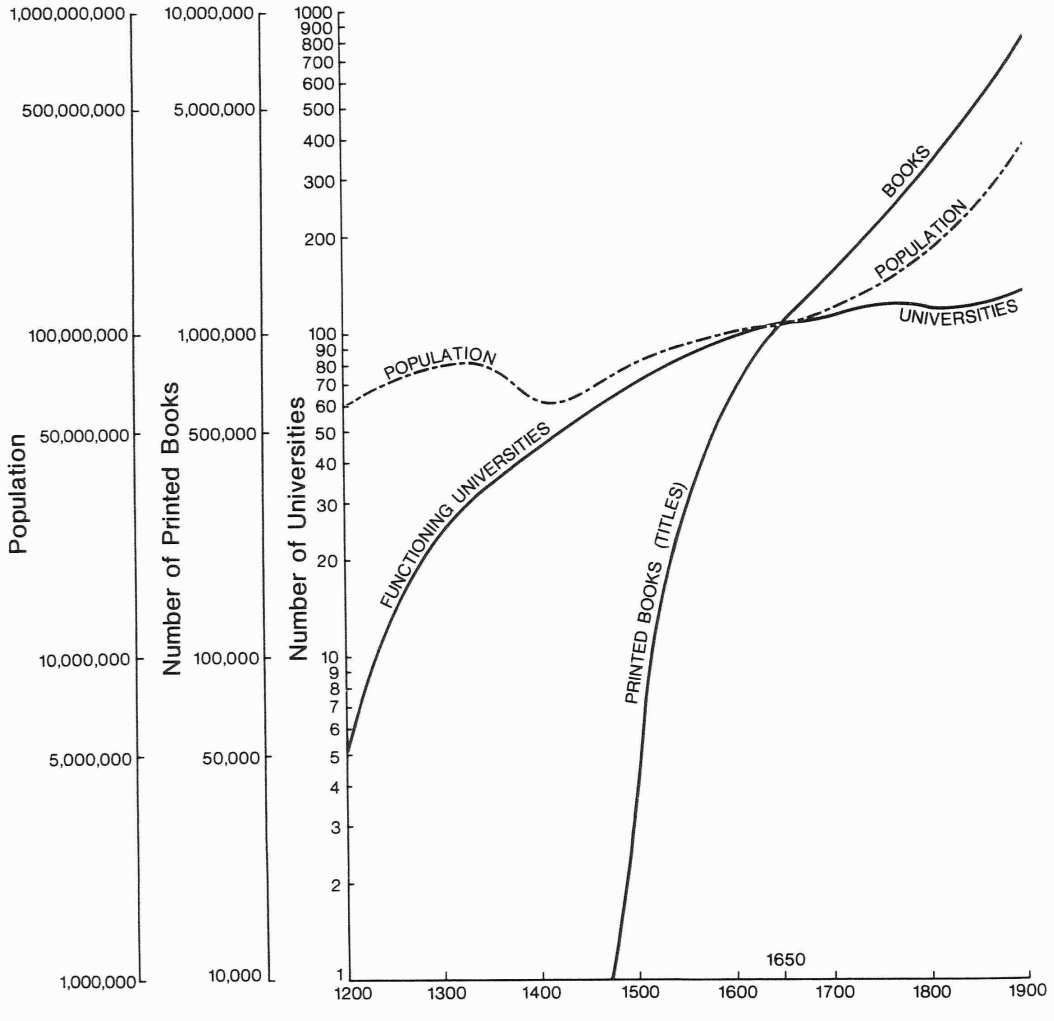


Figure 6. Population, universities and printed books (cumulative total) in Europe 1200 A.D.–1900 A.D. This semi-logarithmic plot shows comparable growth rates for the three separate variables. The scales are positioned to allow for the intersection of growth curves in the year 1650 A.D.

Bernhard Varen, a refugee in the Netherlands from the Thirty-Years War in his native Germany, had, as a youth, studied under the renowned Jungius and Tassius at the progressive Gymnasium in Hamburg, and then at the cautious, conservative, provincial, and, to Varenius, very disappointing University of Königsberg. He soon made his way to the Netherlands where the activities at its younger, livelier, more cosmopolitan, and controversial University of Leiden stimulated his interests in the newer aspects of mathematics and science and where in time he was to be graduated to the degree, Doctor of Medicine.

One learns from his correspondence[6] that, as an aspiring polymath, Varenius had become convinced of the power in the philosophical and scientific concepts of René Descartes (1595–1650), his contemporary at Leiden, to organize and order the voluminous data that he, Varenius, had derived from his own many investigations and extensive readings in many disciplines. The rational skepticism of Cartesius, his mathematics, and also the specific details of

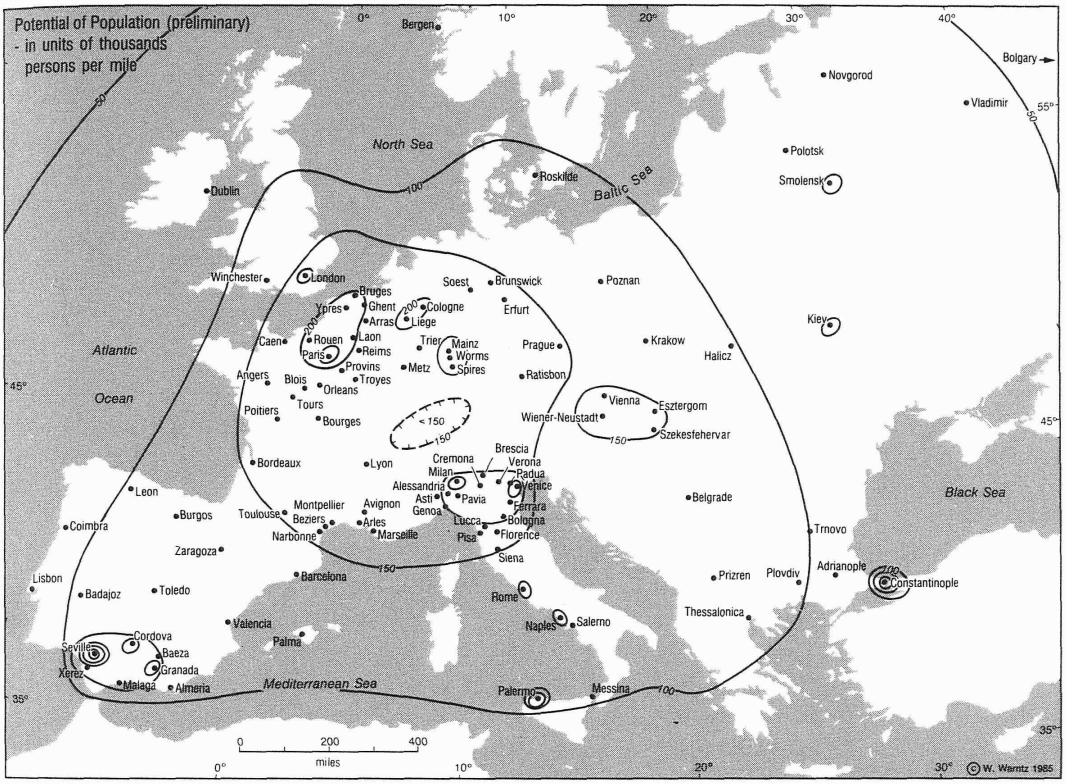


Figure 7. Population potentials in Europe, c. 1200 A.D. Lines of equipotential are scaled in units of thousands of persons per mile. Editor's note: The author's use of the term "preliminary" was not clarified in the available documentation but refers, presumably, to a desire to base a final map on population values for a larger number of places. Details on the construction and use of population potential maps are available in Stewart and Warntz (1968) and Warntz (1979).

his scientific formulations were the strong influences on Varenius when impending poverty, ill health, and career disappointments combined fortuitously with blandishments of the promoters at the Amsterdam branch of the Elsevier publishing house to occasion his writing of what is now acknowledged as the first modern textbook in Geography.

It should be noted that this work, although a lengthy volume (786 pages), very obviously had been rushed through the press in an incomplete and flawed version, but its great popularity, its significance, and its immediate and continuing impact seem not much to have been diminished by this. Its comprehensiveness, pertinence, and currency in the minds of the progressive elements in the developing sciences overrode its defects.

Shortly after the publication in 1650 of the *Geographia Generalis,* the by-then-pathetic life of Varenius came to an end in his twenty-eighth year.

In 1649 Varenius published *Descriptio Regni Iaponiae* and *Tractatus de Religione Iaponiorum.* He dedicated the latter to Queen Christine of Sweden (1626–89) apparently in the hopes of receiving an invitation to a comfortable and secure position in her court of illustrious intellectuals which most recently had been joined by Descartes himself.

Other writings by Varenius included the *Tabulae Historia Universalis* (Amsterdam, 1649); his earlier academic paper at Hamburg, "De Definitione Motus Aristotelica" (1642); "De Lineis Curvis, imprimis de Sectionibus Conicis" (unpublished, Amsterdam, 1648); his medical degree thesis, "Disputatio Medica Inauguralis, De Febri in Genere" (Leiden, 1649); and in drafts

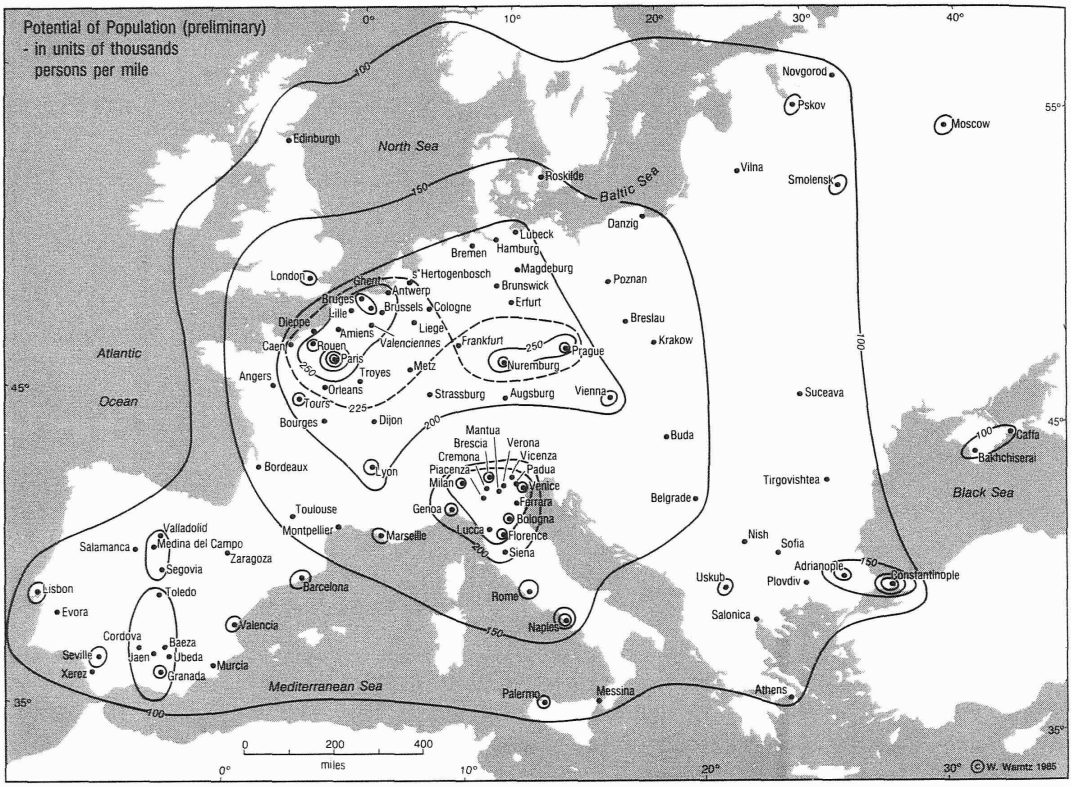


Figure 8. Population potentials in Europe, *c.* 1500 A.D. Lines of equipotential are scaled in units of thousands of persons per mile.

or planned (according to his "Epistola Dedicatoria" in the *Geographia Generalis*), some "Meditationes de Naturalibus Observationibus in Variis Telluribus Partibus" about various forms of nutrition and medicines and medical therapeutics throughout the world; and a regional or "special" geography of the whole world following the pattern established in his own treatment of Japan. His untimely death prevented the attempted accomplishment of the projected works.

To Varenius, Geography was "scientia Mathematica mixta, quae Telluris, partiumque illius affectiones a quantitate dependentes, nempe figuram, locum, magnitudinem, motum, coelestes apparentias, atque alias proprietates affines docet" (a science mixed with Mathematics, which taught [literally teaches] about the quantitative states of the Earth, and of the parts of the Earth, namely shape, place, size, motion, celestial appearances [or bodies], and other related properties).

In thus identifying geography as a branch of mixed [applied] mathematics, Varenius would have appealed to the activists whose concern was with the newly arising organization and systemization of scientific investigation and the ordering of the results. Rival presentations in this Anti-Scholastic movement agreed on many things although conflicting on others. Despite fundamental differences in the schemes as presented by Bacon, Descartes, Hobbes, Grotius, Vossius, Aubrey, Huygens (Varen's younger contemporary at Leiden University), Joachim Jungius, and Isaac Barrow (Newton's predecessor as first Lucasian Professor of Mathematics and Natural Philosophy at Cambridge University) and many others whose concerns were for organizing the "New Learning," there seemed to be complete unanimity in defining Geography in this way. It is offered here as an observation (although at this stage of investigation, it must be a highly tentative one) that the Varenius treatment of Geography and the for-

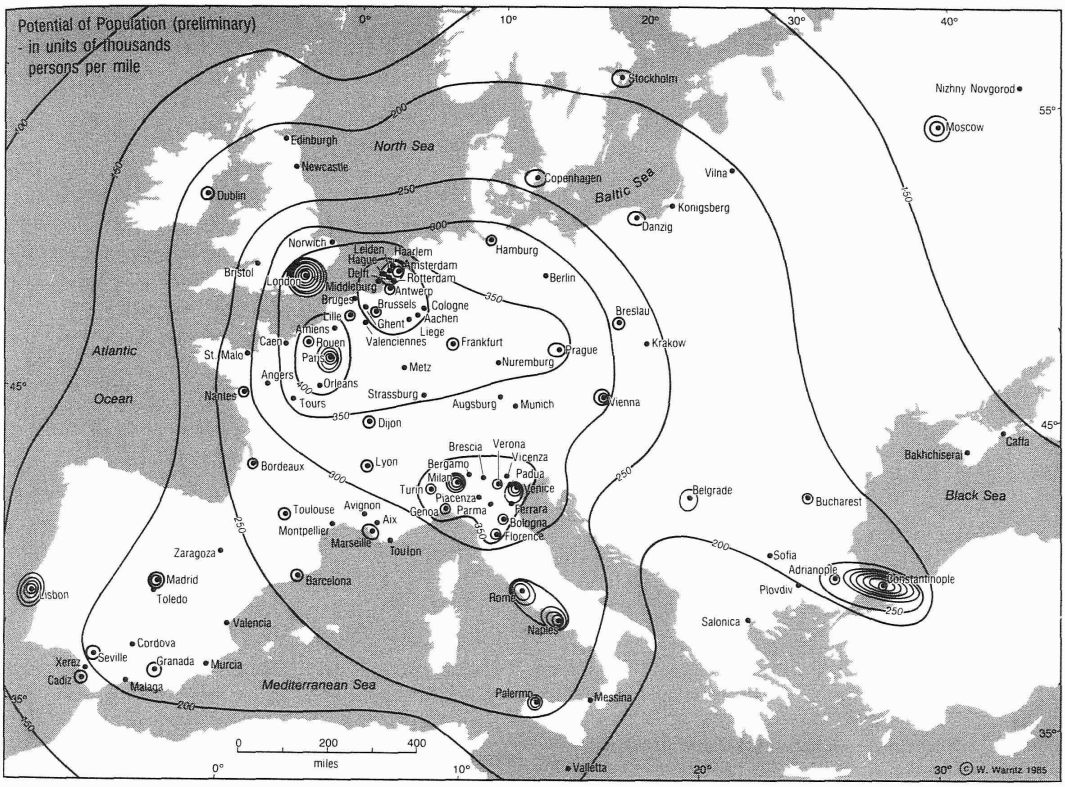


Figure 9. Population potentials in Europe, *c.* 1700 A.D. Lines of equipotential are scaled in units of thousands of persons per mile.

mal position he gives to it, as seems implicit in his work, follows that of Vossius whom he knew on an immediate personal basis; the actual science and philosophy of the *Geographia Generalis* was thoroughly Cartesian.

The *Geographia Generalis* focused, as the title suggests, on general (or universal) geography. General geography was one of the two major divisions (see Fig. 11) of the work, the other being "special" geography, which Varenius defined, outlined, and subdivided but did not here expand upon. General geography was subdivided into three parts:

> *The Absolute part,* which dealt with the form, dimensions and position of the earth; the distribution of lands, water, mountains, woods, deserts; hydrography and the atmosphere.
> *The Relative part,* which dealt with the Appearance and Accidents that happen to it (the earth) from celestial causes: i.e., latitude, climatic zones, longitude, etc.
> *The Comparative part,* which contained an explication of those properties which arise from comparing different parts of the earth together.

In forty chapters Varenius dealt with the rotundity, dimension, movements, and climatic divisions of the earth. Here the works of Copernicus, Kepler, Galileo and especially Descartes were applied for the first time in a major geographical treatise.

He presented various methods of map projection. He noted the study of air, its composition and physical properties, and insisted that laws of motion should form the basis of meteorology. The sun was the source of heat. He drew correlations between movements of air and the "movements" of the sun. He also discussed precipitation and elaborated upon other geographical climatic variations as well as the traditional classical zones.

In the section on hydrography, Varenius made statements concerning the origin of rivers and seas and variations in levels of seas and oceans.

Figure 10. The *Geographia Generalis* by Bernhardus Varenius. Amsterdam, 1650. Title page.

He divided ocean movements into two types (currents and tides), gave Cartesian explanations for their existence, and noted a current flowing out of the Gulf of Mexico, though he seemed not to realize its full climatic importance.

The section in the *Geographia Generalis* on physical features included theories of the origin of mountains, coastal and fluvial shoreline deposition, and morphology. Varenius also supported the idea of erosion by the action of the sea but apparently not, for example, by running surface water.

A planned work (never realized, except for Japan) for a world regional, or "Special" Geography was, as noted, outlined in the *Geographia Generalis* (see Fig. 12).

Clearly, general laws and that which could be demonstrated from them or described with reference to them were of paramount concern to Varenius in this textbook intended for beginning university students. While not denying the necessity of recognizing special geography in the completeness of the whole subject, Varenius insisted that general geography was most suitable for study at higher levels, and he maintained that it had not been receiving proper consideration.

According to Baker (1955), the terms "General" and "Special" geography were not original with Varenius. Bartholomew Keckermann used them in a series of lectures at Danzig in 1603 and in his *Systema Compendiosum: totius mathematices, hoc est, Geometriae, Opticae, Astronomiae, et Geographiae,* published after his death (1617b). Varenius made use of this work and of Keckermann's *Brevis Commentatio Nautica* (1617a). Gölnitz (1643) had stated that "Geography is to be explained externally and internally," but Varenius explicitly rejected these specific terms, so similar to the twentieth-century concepts of "site" and "position," as improper and ill chosen.

Varenius's treatment of general geography was comprehensive, detailed and insightful. His ideas were well in advance of the typical presentation of geography at mid-seventeenth century and reasonably current in science generally. It must always be remembered, however, that the work was intended simply as a textbook for beginning university students and not as an advanced treatise for scholars. The mathematics, so strongly endorsed and stressed, were appropriately at an intermediate level. In Europe, England, and in later editions in America, however, the work was also read with approval by those at the highest levels without as well as within the universities.

To the world of learning generally, and in the popular mind in Holland and elsewhere, Varenius (posthumously) came to be known within a decade as "THE Geographer." (The study of his correspondence, however, suggests that this certainly was not his goal in life and probably would have astonished him had he lived to see it.)

The place of the work itself, at least as its author perceived it, in the general intellectual scheme of things in mid-seventeenth century Europe can be assayed from Varenius's statements in his "Epistola Dedicatoria" to those establishment members in Holland whose support and patronage he sought.

In those prefatory remarks, for example, Varenius took considerable care to argue for and demonstrate the "unity of nature." In essence, Varenius joined in the attempt to overthrow the Scholastics' statement of the Aristotelean

GENERAL GEOGRAPHY

has been divided into
three parts in this book

2. RELATIVE PART
explaining celestial properties by chapters

1. ABSOLUTE PART
divided into six sections

3. COMPARATIVE PART
considering those properties which arise from the comparison of one place to another

FIRST SECTION two chapters of preliminaries	Ch. I. Ch. II.	Prologue. Concerning certain necessary things from Geometry.
SECOND SECTION the properties of the whole earth explained in the five chapters	Ch. III. Ch. IV. Ch. V. Ch. VI. Ch. VII.	Concerning the shape of the Earth. Concerning its measurement and size. Concerning its motion. Concerning its places in the System of the World. Concerning its substance and material.
THIRD SECTION in which the constitution and the parts of the land are explained in four chapters	Ch. VIII. Ch. IX. Ch. X. Ch. XI.	Concerning the Division of the Land by the Waters. Concerning Mountains in general. Concerning the differences of Mountains. Concerning Forests, deserts and springs.
FOURTH SECTION in which the constitution and properties of waters are explained in six chapters	Ch. XII. Ch. XIII. Ch. XIV. Ch. XV. Ch. XVI. Ch. XVII.	Concerning the Division of the Waters. Concerning the Ocean and the Sea. Concerning the Motions of the seas, especially the Ebb and Flow. Concerning Rivers. Concerning Lakes, stagnant and marshy. Concerning mineral waters.
FIFTH SECTION	Ch. XVIII.	Concerning the change of dry places into rainy ones.
SIXTH SECTION concerning the Atmosphere	Ch. XIX. Ch. XX. Ch. XXI.	Concerning the Atmosphere and the Air. Concerning Winds in general. Concerning the differences of Winds, and in kind.

Ch. XXII.	Concerning celestial properties in general.
Ch. XXIII.	Concerning the latitude of a place and the elevation of the pole.
Ch. XXIV.	Concerning the Division of the Earth into Zones.
Ch. XXV.	Concerning the length of the days and the division of the Earth into Climates.
Ch. XXVI.	Concerning Light, heat, and the seasons of the year.
Ch. XXVII.	Concerning shadows and the division of inhabitants in respect of shadows.
Ch. XXVIII.	Concerning the comparison of celestial Properties in various places, where the Antoci, Perioeci, and Antipodes are.
Ch. XXIX.	Concerning the Diversity of Time in various times.
Ch. XXX.	Concerning the different rising of the Sun, Moon, etc. and also other appearances.

Ch. XXXI.	Concerning the longitude of places.
Ch. XXXII.	Concerning the location of places with respect to each other.
Ch. XXXIII.	Concerning the mutual distance of places.
Ch. XXXIV.	Concerning the Horizon of visibility.
Ch. XXXV.	Concerning the Nautical art in general and the construction of ships.
Ch. XXXVI.	Concerning the burden to be placed on ships.
Ch. XXXVII.	Concerning the Directory of the art of navigation. First Part. The Knowledge of distances.
Ch. XXXVIII.	The Second Part. The Knowledge of directions.
Ch. XXXIX.	The Third Part. Concerning the Histiodrome, or the way of a ship.
Ch. XL.	The Fourth Part. Concerning the place of ship on its way.

Figure 11. The organization and titles of the forty chapters accomplished in Varenius's *Geographia Generalis,* Amsterdam, 1650.

SPECIAL GEOGRAPHY

considers three kinds
of things in individual
regions

1. TERRESTRIAL
(10)

1. Limits and Boundary.
2. Longitude of a place and situation.
3. Shape.
4. Magnitude.
5. Mountains — the name of them and situation, altitude, properties and contents.
6. Mines.
7. Forests and deserts.
8. Waters — see lakes, marshes
   Rivers, their springs, origin, extent, width, abundance of water, speed, quality of water, cataracts, etc.
9. Fertility or Barrenness, and Fruits.
10. Animals.

2. CELESTIAL
(8)

1. Distance of a place from the Equator and the Pole.
2. Obliquity of motion above the Horizon.
3. The length of days.
4. The Climate and Zone.
5. Heat, and also the seasons of the year, winds, rains, and other meteors.
6. The rising and duration of Stars above the Horizon.
7. Stars passing across the Zenith of the place.
8. Quantity, or rather the speed of motion according to the Copernican hypothesis.

3. HUMAN
(10)

1. The stature of the Inhabitants, the life, food and drink, origin, etc.
2. Profitably activities and arts, commerce, wages.
3. Virtues and vices, ingenuity, learning etc.
4. Customs concerning births, weddings, funerals.
5. Common speech and language.
6. Political Government.
7. Religion and the status of Ecclesiastical matters.
8. Cities.
9. Memorable Histories.
10. Illustrious men or women, crafts, inventions.

Figure 12. The outline only given for Special Geography by Varenius in the *Geographia Generalis,* Amsterdam, 1650, but essentially used earlier in his *Descriptio Regni Iaponiae,* Amsterdam, 1649.

cosmology with its conception of different orders of being and perfection and the essential assertion that everything in the heavens was perfect and divinely ordered while on earth matter and motion were imperfect and corrupted. These conceptions were being attacked on a multitude of fronts in science and art and with an increasing boldness. It is worth examining the *Geographia Generalis* as a work of the rising skepticism joining reason and empiricism. Two additional "editions" from Amsterdam—1664 and 1671—of the *Geographia*

Generalis Varenii were required to meet the surging demand for it. No changes in text were made although the type and format were changed for the 1664 edition, the one in 1671 being a reissue of that one. In neither case were attempts made to redress the errors and insufficiencies of the original text.

The Newton Cambridge Editions of the *Geographia Generalis Varenii*

As noted above, the original edition of the *Geographia Generalis* by Varenius is significant in the very important respect that it embodied and exemplified the philosophy and the physics of Descartes. This work along with other thoroughly Cartesian works proved *initially* attractive to the Cambridge Platonists in their continuing search for an accommodation of religion and natural philosophy, and the introduction of the *Geographia Generalis* into Cambridge University in the 1660s can be seen as part of the Cambridge Platonist movement.

That ancient Aristotelean-Platonic debate concerning the relationship of the general to the special—the universal to the particular—was a focus of attention in the seventeenth and eighteenth century search for system in the various fields of learning as it had been much earlier in the classical world. Judging from the numbers of extant copies now in England, at various libraries and in other holdings, of the several Amsterdam editions of the *Geographia Generalis,* it was a flood of 1664 copies that had the decisive effect. All evidence suggests its introduction at that time into the studies of Cambridge University by Isaac Barrow as the first Lucasian Professor of Mathematics and Natural Philosophy. The statutes of the Lucasian Professorship contain the explicit requirements that, among other things, the said Professor shall be responsible for instruction in and shall lecture in Geography. Such an arrangement was entirely within the frameworks of learning alluded to earlier providing that Astronomy and Geography as mixed mathematics be found in the curriculum under the Professor of (pure) mathematics and natural philosophy (mixed, i.e., applied mathematics). The Isaac Barrow Papers support this idea.

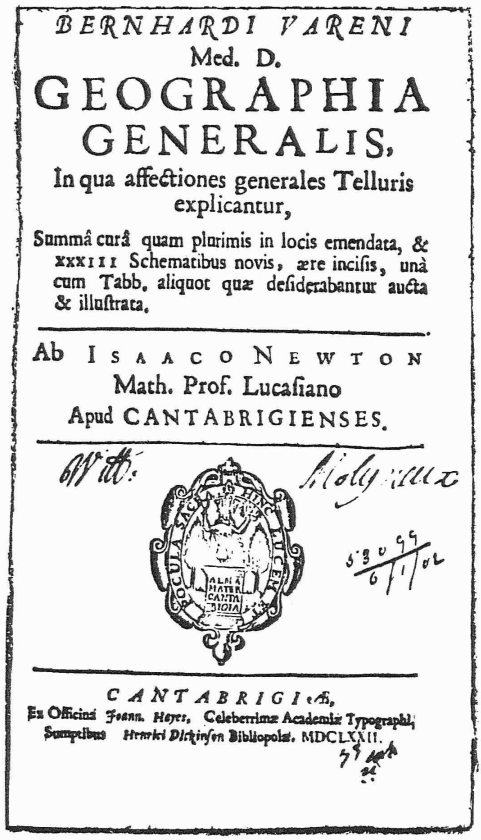
Isaac Newton, as the second incumbent (1669) of the Lucasian Professorship, may or may not have lectured on Geography in Cambridge University. There is no *direct* evidence as yet that he ever did. There is no shortage of direct evidence, however, that the *Geographia Generalis,* in its 1664 Amsterdam edition and subsequent Cambridge ones (Newton 1672, 1681; Jurin 1712) was very widely used and frequently cited. Probably it was from his characteristic conscientiousness and his well-developed sense of responsibility that Isaac Newton undertook to revise, emend, correct, and substantially to add to the *Geographia Generalis Varenii* since it was in short supply, being so widely used by the students of the university. Especially was this so, too, because of Newton's own approval of or at least acceptance of and concurrence with the organization and content of the work. There is drama in this, however, because Newton's own research and writings subsequently would require and ultimately did occasion substantial changes in the content of the work.

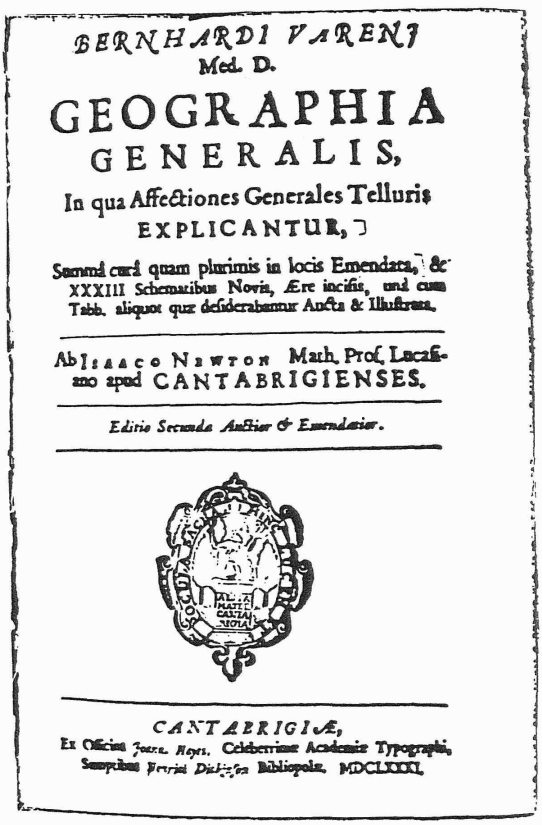
Although I was unable to find any "deposited lectures" in Geography by Newton at Cambridge University, there is one tantalizing and provocative bit of relevant information from the Preface of Dugdale's and Shaw's *A Compleat System of General Geography,* 1733 (1734, 1736, and 1765). Concerning the *Geographia Generalis* they state that:

> THE Original of this Work was Re-printed at *Cambridge* in the Year 1672, for the Use of the Students in *that University*; and an Advertisement was given of it, the Beginning of the Year following, in the *Philosophical Transactions,* No. 91, 1673, p. 5172.
>
> THE *Dutch* edition [i.e. published in Amsterdam—the language was Latin] being then out of Print, was carefully corrected, in many Places enlarged and improved, and the necessary *Tables and Schemes* supplied by the Illustrious Sir ISAAC NEWTON, at that Time *Lucasian Professor of Mathematics* in that University.
>
> THE Reason why this great Man took so much Care in Correcting and Publishing our Author, was, because he thought him necessary to be read by his Audience, *the Young Gentlemen of Cambridge,* while he was delivering Lectures upon the *same Subject* from the *Lucasian Chair* . . . .

What a revelation! Further citations from this preface will follow but, at this time, perhaps a comment about the credibility of its author, Peter Shaw, M.D., is in order.

Shaw was another dedicated Newtonian and thoroughly knowledgeable about and conversant with the detailed activities of the life of Isaac Newton no less than his mathematics and


BERNHARDI VARENI
Med. D.
GEOGRAPHIA
GENERALIS,
In qua affectiones generales Telluris explicantur,
Summâ curâ quam plurimis in locis emendata, & XXXIII Schematibus novis, ære incisis, unà cum Tabb. aliquot quæ desiderabantur aucta & illustrata.
Ab ISAACO NEWTON
Math. Prof. Lucasiano
Apud CANTABRIGIENSES.
CANTABRIGIÆ,
Ex Officina Joann. Hayes, Celeberrimæ Academiæ Typographi,
Sumptibus Henrici Dickinson Bibliopolæ. MDCLXXII.


BERNHARDI VARENI
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GEOGRAPHIA
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In qua Affectiones Generales Telluris
EXPLICANTUR,
Summâ curâ quam plurimis in locis Emendata, & XXXIII Schematibus Novis, Ære incisis, una cum Tabb. aliquot quæ desiderabantur Aucta & Illustrata.
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Editio Secunda Auctior & Emendatior.
CANTABRIGIÆ,
Ex Officina Joann. Hayes, Celeberrimæ Academiæ Typographi,
Sumptibus Henrici Dickinson Bibliopolæ. MDCLXXXI.

Figure 13. Title pages of the two Isaac Newton Cambridge editions of the *Geographia Generalis Vareni* (sic), 1672 and 1681.

science. Shaw's own writings in medicine and chemistry were voluminous and important. In London he was a successful and popular physician, becoming, in 1752, the royal physician-extraordinary to King George II and was created doctor of medicine by royal mandate at Cambridge in that same year. His most valuable literary work was his editing of the works of Francis Bacon and Robert Boyle. His extensive works also included the translations of the works of Stahl and Boerhaave, the towering figure in medicine at Leiden University.

Although certain aspects of his opportunistic career may not bear close scrutiny, one cannot dismiss summarily Peter Shaw's assertion of lectures in Geography by Isaac Newton at Cambridge University. There was nothing "political" in this.

As to the revisions and additions Newton made to the *Geographia Generalis Varenii*[7] (see Fig. 13), they *were* many and substantial. The most obvious contributions are the schemes (figures) and tables that Newton introduced (see Figs. 14–15). In his letter of 25 May 1672 to John Collins, London mathematician and civil servant, Newton answered an earlier query of Collins concerning what book he, Newton, had at the press in Cambridge. "The book here in the press," he wrote, "is Varenius his Geography, for which I have described schemes, and I suppose it will be finished about six weeks hence." It was, and Newton sent Collins a copy. The casual way in which Newton mentioned "Varenius his Geography" is quite in keeping with the knowledge that the Amsterdam edition of 1664 already was well known in England.

But Newton's attention to this, his first book (see Cajori 1929) far exceeded just the designing of schemes and the supplying of tables. On virtually every page, grammatical and typo-

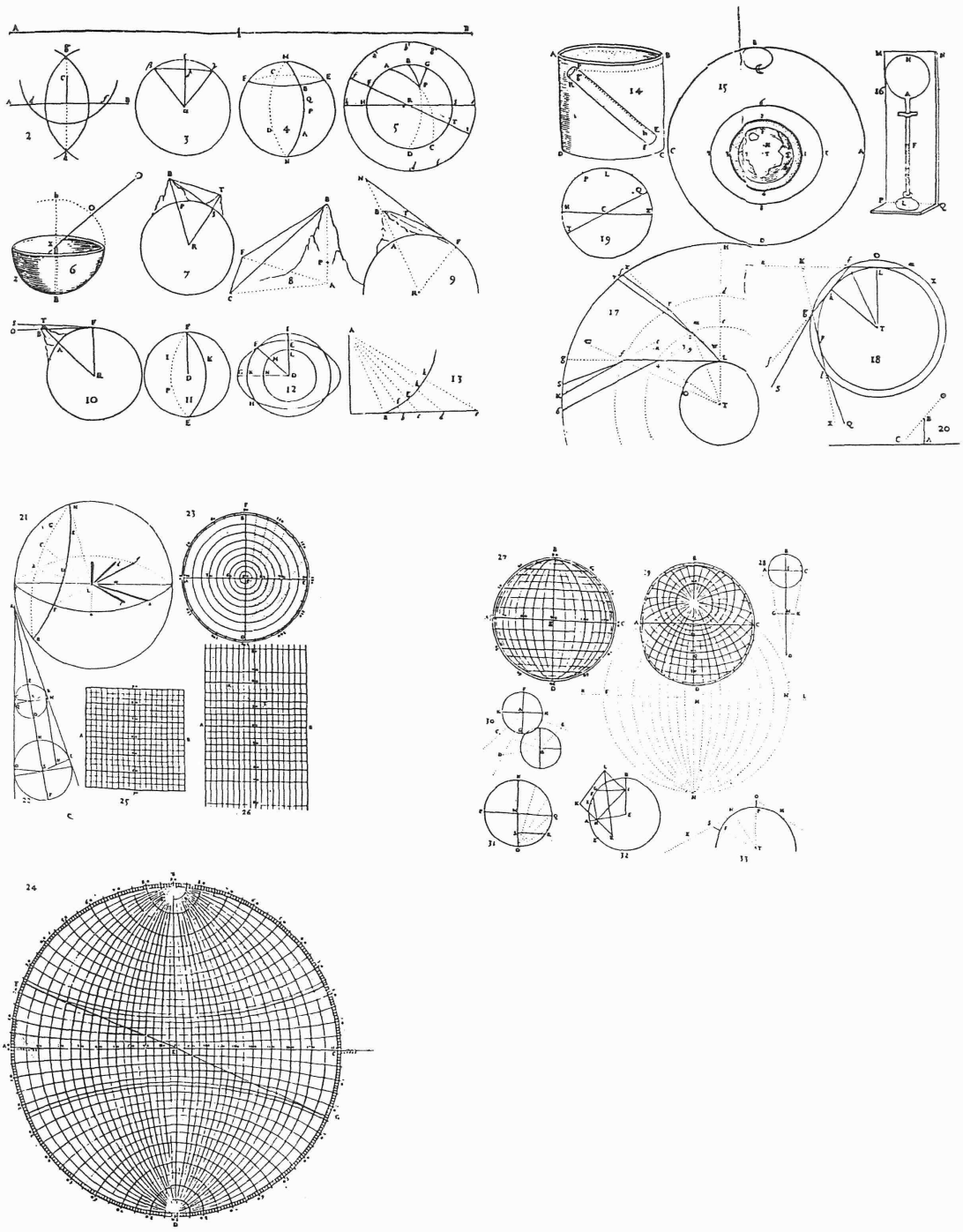
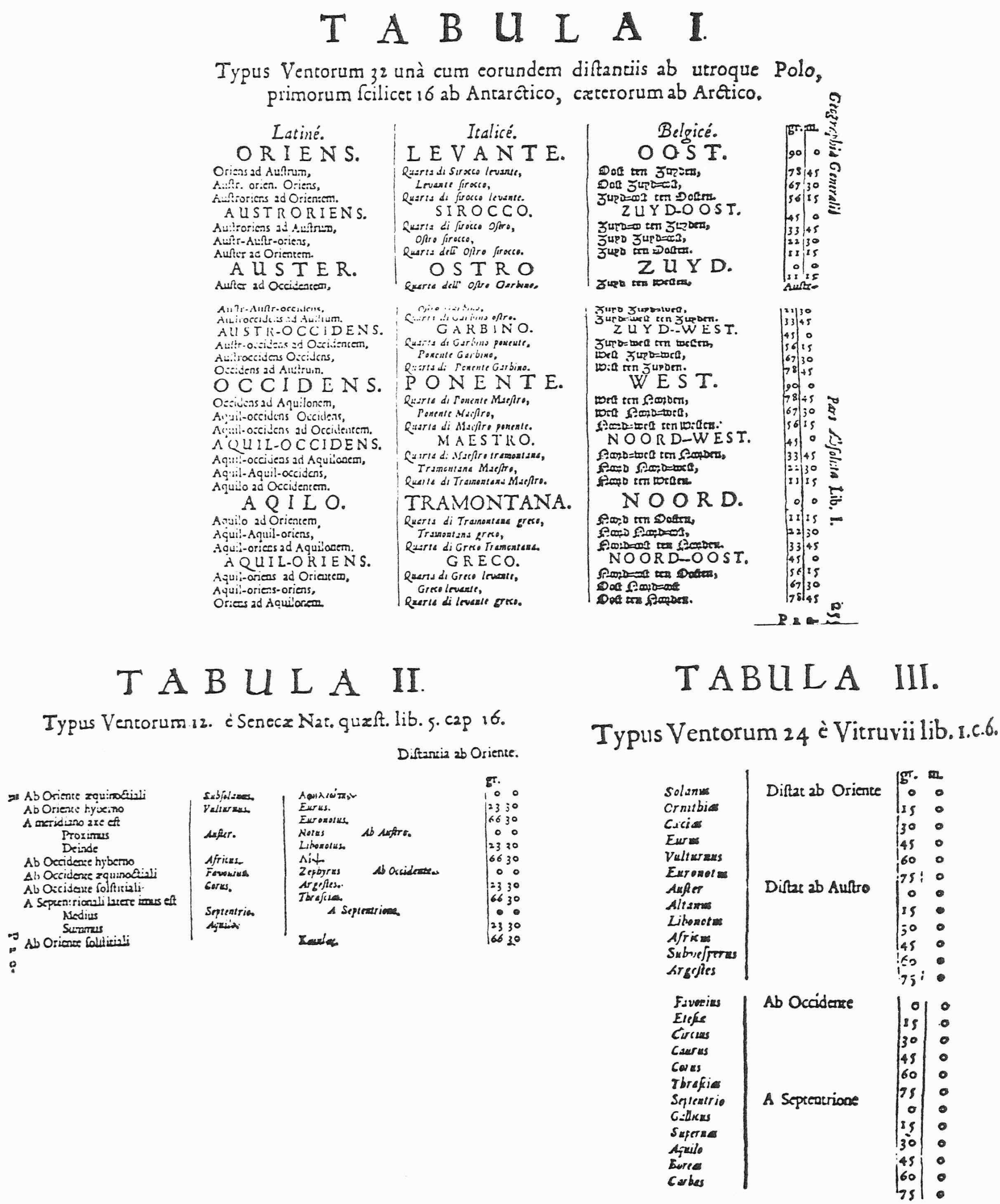


Figure 14. The *schemes* included by Isaac Newton in his two Cambridge editions of the *Geographia Generalis Varenii*, 1672 and 1681. Numbers 1, 10, 15, 17 and 18 appeared in the original *Geographia Generalis* by Varenius. Newton redrew numbers 10, 17 and 18 and introduced 28 new schemes. Numbers 5, 6 and 7 are used to explain methods that Varenius employed in determining the size of the earth. Number 15 was derived by Varenius from Descartes's illustration of the "Plenum and Vortices and the Tidal Flux and Reflex of the Seas on Earth."



TABULA I.

Typus Ventorum 32 unà cum eorundem distantiis ab utroque Polo, primorum scilicet 16 ab Antarctico, cæterorum ab Arctico.

Latiné.	Italicé.	Belgicé.	gr.	m.
ORIENS.	LEVANTE.	OOST.	90	0
Oriens ad Austrum,	Quarta di Sirocco levante,	Oost ten Zuyden,	78	45
Austr. orien. Oriens,	Levante sirocco,	Oost Zuyd-oost,	67	30
Austroriens ad Orientem.	Quarta di sirocco levante.	Zuyd-oost ten Oosten.	56	15
AUSTRORIENS.	SIROCCO.	ZUYD-OOST.	45	0
Austroriens ad Austrum,	Quarta di sirocco Ostro,	Zuyd-oost ten Zuyden,	33	45
Austr-Austr-oriens,	Ostro sirocco,	Zuyd Zuyd-oost,	22	30
Auster ad Orientem.	Quarta dell' Ostro sirocco.	Zuyd ten Oosten.	11	15
AUSTER.	OSTRO	ZUYD.	0	0
Auster ad Occidentem,	Quarta dell' Ostro Garbino.	Zuyd ten westen,	11	15
Austr-Austr-occidens,	Ostro garbino,	Zuyd Zuyd-west,	22	30
Austroccidens ad Austrum.	Quarta di Garbino ostro.	Zuyd-west ten Zuyden.	33	45
AUSTR-OCCIDENS.	GARBINO.	ZUYD-WEST.	45	0
Austr-occidens ad Occidentem,	Quarta di Garbino ponente,	Zuyd-west ten westen,	56	15
Austroccidens Occidens,	Ponente Garbino,	West Zuyd-west,	67	30
Occidens ad Austrum.	Quarta di Ponente Garbino.	West ten Zuyden.	78	45
OCCIDENS.	PONENTE.	WEST.	90	0
Occidens ad Aquilonem,	Quarta di Ponente Maestro,	West ten Noorden,	78	45
Aquil-occidens Occidens,	Ponente Maestro,	West Noord-west,	67	30
Aquil-occidens ad Occidentem.	Quarta di Maestro ponente.	Noord-west ten Westen.	56	15
AQUIL-OCCIDENS.	MAESTRO.	NOORD-WEST.	45	0
Aquil-occidens ad Aquilonem,	Quarta di Maestro tramontana,	Noord-west ten Noorden,	33	45
Aquil-Aquil-occidens,	Tramontana Maestro,	Noord Noord-west,	22	30
Aquilo ad Occidentem.	Quarta di Tramontana Maestro.	Noord ten Westen.	11	15
AQILO.	TRAMONTANA.	NOORD.	0	0
Aquilo ad Orientem,	Quarta di Tramontana greco,	Noord ten Oosten,	11	15
Aquil-Aquil-oriens,	Tramontana greco,	Noord Noord-oost,	22	30
Aquil-oriens ad Aquilonem.	Quarta di Greco Tramontana.	Noord-oost ten Noorden.	33	45
AQUIL-ORIENS.	GRECO.	NOORD-OOST.	45	0
Aquil-oriens ad Orientem,	Quarta di Greco levante,	Noord-oost ten Oosten,	56	15
Aquil-oriens-oriens,	Greco levante,	Oost Noord-oost	67	30
Oriens ad Aquilonem.	Quarta di levante greco.	Oost ten Noorden.	78	45

TABULA II.

Typus Ventorum 12. è Senecæ Nat. quæst. lib. 5. cap 16.

Distantia ab Oriente.

				gr.	
Ab Oriente æquinoctiali	Subsolanus.	Ἀφηλιώτης		0	0
Ab Oriente hyberno	Vulturnus.	Eurus.		23	30
A meridiano axe est		Euronotus.		66	30
Proximus	Auster.	Notus	Ab Austro.	0	0
Deinde		Libonotus.		23	30
Ab Occidente hyberno	Africus.	[illegible]		66	30
Ab Occidente æquinoctiali	Favonius.	Zephyrus	Ab Occidente.	0	0
Ab Occidente solstitiali	Corus.	Argestes.		23	30
A Septentrionali latere imus est		Thrascias.		66	30
Medius	Septentrio.		A Septentrione.	0	0
Summus	Aquilo.			23	30
Ab Oriente solstitiali		[illegible]		66	30

TABULA III.

Typus Ventorum 24 è Vitruvii lib. 1. c. 6.

		gr.	m.
Solanus	Distat ab Oriente	0	0
Ornithiæ		15	0
Cæcias		30	0
Eurus		45	0
Vulturnus		60	0
Euronotus		75	0
Auster	Distat ab Austro	0	0
Altanus		15	0
Libonotus		30	0
Africus		45	0
Subvesperus		60	0
Argestes		75	0
Favonius	Ab Occidente	0	0
Etesiæ		15	0
Circius		30	0
Caurus		45	0
Corus		60	0
Thrascias		75	0
Septentrio	A Septentrione	0	0
Gallicus		15	0
Supernas		30	0
Aquilo		45	0
Boreas		60	0
Carbas		75	0

Figure 15. The wind tables introduced by Isaac Newton into his Cambridge editions (1672 and 1681) of the *Geographia Generalis Varenii*. The antiquity of these tables are in sharp contrast to the modernity of Newton's schemes (Fig. 14).

graphical errors were corrected. Some awkward portions of the text were rewritten and qualifying phrases added as in the discussion of map projections. More importantly, a large number of computational errors were corrected and better estimates of constant values were supplied.

For example, Newton changed "Itaque ut 7

gr. 30 min. ad 1 gr. sive ut 1/48 ad 1/360, hoc est, ut 48 ad 360 ita 5000 ad 666-2/3 stadia" into "Itaque ut 7 gr. 30 min. ad 1 gr. sive ut 1/48 ad 1/360 hoc est, ut 360 ad 48 ita 5000 ad 666-2/3 stadia" in the discussion in Chapter IV concerning the mensuration and magnitude of the earth. Whereas Varenius had stated that the moon's distance from earth is 40 earth radii, Newton changed that value to 59.

The measurement of a degree of latitude on the earth's surface according to Professor Snellius (Willebrord Snell 1591–1626) of Leiden University was reported as "28500 perticarum . . . hae faciunt 19-147/150 mill." This expression of perches in Dutch miles by Varenius is in error. Newton detected it and of the "28500 perticarum" he said "hae faciunt 18-147/150 mill."

Newton used three of the geometric figures (numbers 5, 6, 7; see Fig. 14), which he introduced to help explain the seven methods of determining the size of the earth as described by Varenius. The above noted measurement owing to Snellius (1617) was reviewed critically by Varenius. According to Cajori (1929, 415) Newton's correction of the Snellius error is "conclusive proof" that, at least by 1672, Newton had "familiarized himself with the results" of the meridian measurement by Snellius. Pertaining to this, the 1664 Amsterdam edition of the Varenius work was widely circulated at Cambridge and doubtless was seen by Newton well before he began his 1672 version of same.

Newton also corrected in 1672 the Varenius tabulation of the distances at which mountain peaks of various elevations might be seen at sea (disregarding refraction which itself was treated in other places in the work). The Varenius determination, for example, that a peak with a height of, say, one German mile could be seen at a distance of 29¼ German miles was revised to read 41½ German miles by Newton. This, along with the Varenius statement regarding German miles "quorum XV faciant XIX millaria Hollandia" is yet further evidence to be considered by those interested in investigating the twenty-year delay from 1666 when Newton apparently made his first earth-moon test of his law of gravitation until his formal presentation of it in his completed manuscript in 1686 for his *Philosophiae Naturalis Principia Mathematica,* that is, his celebrated "Principia."

Thus, said Cajori (1929), all of this evidence makes it certain that Newton knew the new estimate by Snellius of the earth's circumference in 1672. (Without wishing to belabor the point, attention again is called to the very strong likelihood that he did know the value as early as 1666 itself.) This Snellius value (although a little small) *would* "yield a fairly satisfactory agreement between computed and observed values in the earth-moon test." These data "constitute a strong and additional argument against the old theory that Newton's delay of twenty years in announcing the law of gravitation" was owed to his use of a much too small value for the earth's radius. Rather, his delay in solving the problem (in 1684 at the earliest) was because of a very difficult theoretical question relating to the attraction of a sphere upon an external point (Whiteside, n.d.).

One of the features of the text that had been incorporated by Varenius in 1650 was a Table of Latitude and Longitude for 226 of the Most Famous Places of the World.[8] Varenius knew personally members of the famous Blaeu Cartographic and Map Publishing Firm of Amsterdam and so he probably had more than routine access to the latest estimates of Latitude and Longitude for those places. Even so in the rush to publication (no doubt unmitigated by any concern the Elzeviers might have allowed to interfere with their wish to capitalize while they still could on their investment in an author with failing health), Varenius left blank at least one of the two coordinates, notably longitude, for 31 of the places. Newton did fill in only some of these blanks but he did also enter better estimates (in what was then a fluid affair) for a number of places, e.g. Eboracum (York). This better estimate for York of its latitude presumably derived from the Englishman Norwood's precise measurement earlier (1635) of the distance from York to London. When Newton had learned of this 1635 value seems not to be known, but, in reference to the discussion above, it should be noted that Norwood had provided an even more accurate estimate of the earth's circumference than Snellius. (Norwood had estimated 69½ English statute miles to a degree of latitude along a meridianal arc as against the equivalent of 66⅔ such units by Snellius.) Nowhere in Newton's papers or elsewhere has evidence been found that he mentioned any specific value before the appearance of the "Principia" when he used the value found by J. Picard in France of the equivalent of 69⅓ English statute miles to a degree of latitude.

Discussion in full of the entire gamut of Newton's schema and tables added to the text and the wide variety of textual changes and corrections made by him must be reserved for another time and place. Let it suffice to say that the very modern diagrams that Newton added to the text included (besides the three already noted concerning the determination of the size of the earth) a wide range dealing with both pure mathematics (geometrical essentials in the study of geography) and mixed mathematics (refraction, altitudes, bearings, time, navigation, cartography and map projections, shadows and sun dials, and so on). Of the 33 schema (see Fig. 14), five of them (numbers 1, 10 redrawn, 15, 17 redrawn, and 18 redrawn) had actually appeared unnumbered in the original *Geographia Generalis Varenii*. All of the others (a total of 28 new ones in all) were introduced by Newton. The retention unmodified (number 15) from Varenius of Descartes's own illustration of the Plenum and Vortices and the Tidal Flux and Reflex of the Seas on Earth serves at once to illustrate yet other aspects of the Newton character—his cautious and conservative wish not to rush precipitously to declarations of novel findings, including his own, and the long-enduring nature of his earlier established respect and high regard for Descartes's presentations until the full break (in Physics) did come in 1686.

Viewing the modernity of the figures against the antiquity of the wind tables introduced into the work by Newton serves to reinforce our earlier point about the ambivalent nature of mid-seventeenth century science as it underwent such rapid change.

In his 1681 Cambridge edition, Newton made a number of additional minor adjustments and some sections he changed substantially. For example, the material on the behavior of shadows within the tropics was completely rewritten. To the table showing latitude and longitude of famous places in the world, Newton added Cambridge. Is it too difficult to imagine that this was brought about by some good-natured bantering in the senior common room at Trinity College, Cambridge, seeing that Oxford had been included with full coordinates by Varenius from the very beginning in 1650?

The editions of the *Geographia Generalis Varenii* by Isaac Newton epitomize his continuing care and delight in the use of geometry as not only in itself a logical system, but also as a powerful instrument for both scientific investigation and the presentation of its results. Geography, Geometry, and Graphics—the graphical portrayals of the geometrical conceptions of geographical phenomena—characterize the work and presage the "Principia" itself particularly in the "mixed" mathematics of those very geographical sections of Book III, "The System of the World," where, with the urging and aid of Edmond Halley, the "Newtonian" alternatives to the Cartesian science of Varenius in Geography emerge unequivocally.

The Jurin Cambridge Edition of the *Geographia Generalis Varenii*

In time, however, Newton's 1681 edition of the *Geographia Generalis Varenii* itself became a cause of concern for the emerging Newtonian contingent at Cambridge and for two quite distinct reasons. One of these concerned the increasing popularity of the work and the scarcity of copies that that engendered. As for the other, the actual content of the work, ironically, was being used against the Newtonians themselves by the strong and well-organized Cartesian faction now so well entrenched at Cambridge. For example, certain Anti-Newtonians, the Tutors Greene and Waterland, in their enthusiasm for the Cartesian system, urged in their published guides and advice for the studies of their students that they read, among other things, the *Geographia Generalis Varenii* (Newton 1681), as epitomizing it.

As to the first reason, let us recall again the Dugdale and Shaw Preface of 1733 and note again their retrospective look at events in the continuing concern for the Geography of Varenius.

Peter Shaw continued:

> And tho' many Hundreds were then [1681] printed at *Cambridge*, and from that Edition often reprinted abroad; yet by being frequently read in both *Universities* [N.B. both], all the Impressions were in time sold off; so that their *Scarcity* among the Booksellers was observed by the Reverend DR. BENTLEY to be a great Detriment to the *Young Gentlemen of Cambridge* in perfecting their studies.
>
> WHEREUPON this worthy Encourager and Advancer of all sorts of Literature, *importuned* the Learned DR. JURIN (as being the fittest Person) to take *particular* Care of a new Impression; and, for the Benefit of the younger Students, to supply the

Defects of *Varenius* with an *Appendix,* containing the later Discoveries and Improvements.

TO Him therefore is owing that correct *Edition of Varenius* with an excellent *Appendix,* printed in the year 1712 (Dugdale and Shaw 1733).

Lest perspective be lost, however, we must once again recognize also the still strong medieval character of much of the Cambridge curriculum untouched in theology (the Platonists notwithstanding) and its reverence for Aristotelean scholasticism. Later international recognition for the Newtonians and the subsequent strengths in mathematics and natural science at Cambridge tend to obstruct our rear views and disguise the fact that Cambridge was a lethargic, quiet, and conservative place and becoming increasingly so while Sir Isaac was being lionized in London. From this generalization, however, we must at least except Trinity College and its Master, the percipient Dr. Richard Bentley.

When the classicist, Richard Bentley, that extraordinarily talented but nonetheless cantankerous and contentious Master of Trinity College, Cambridge, persuaded his two young colleagues, Roger Cotes and James Jurin, in 1709 to undertake the revisions leading to the publication of the works noted above, he himself may have had certain quite distinct, though perhaps in his own mind not separable, motives. The loftiest of these was the promotion and advancement of Newtonian science complementing his plan that Trinity College indeed become "a house of all kinds of good letters." To this end Bentley seemed determined to use the Cambridge University Press, of which he had gained control and had reorganized and infused with vitality. Even allowing for the fact that the *Geographia Generalis Varenii,* from its inception in Amsterdam in 1650, was never intended to be other than an introductory textbook for beginning university students in general geography and that the "Principia" was intended at least by Halley, if not by Newton himself (and subsequently was recognized), as an inordinately powerful statement of the highest order in revolutionizing physical science, their essentially simultaneous new revision and publication by the same group of scholars, along with the wide variety of other books Bentley sponsored, mark him as a progressive—one who associated with men whose thought and actions were formative. Bentley recognized "the importance . . . of unified knowledge, of relatedness, whether between Newtonian physics and theology or scientific method and scholarship." Almost alone among critics, "he perceived the implications for the classics of the natural scientists' search for demonstrable authority. Nor was he one to shrink from the further assumption to which this perception committed him—the obligation to start anew, and with fresh principles and a scrupulous regard for evidence to re-do the work of the past. But the *sine qua non,* the necessary instrument, for such a programme, was a learned Press" (McKenzie 1966, Vol. 1, 9).

The re-doing of the *Geographia Generalis Varenii* meant the hastening and reinforcement of its transformation from a thorough-going Cartesian work into a Newtonian statement. In this, the processes and especially the editorial techniques and devices used in the 1712 Jurin edition were similar to and, of course, not unrelated to Samuel Clarke's marvelous sequence of revised editions of Rohault's (Cartesian) *Physica,* and are to be understood in the same terms and circumstances, especially in the use of parallel statements to allow these works to be read either as a Cartesian or as a Newtonian statement. This served well a second motive for Bentley—the profit-seeking one for his own benefit and that of the University Press in that such an organization of the book could serve both of the potential markets.

Another motive unique to Bentley was to use works such as these of Cotes and Jurin, and other books of the University Press in general, as direct offensive weapons in his own long, harrowing, and bitter "warfare" with the senior members of his own college. Between 1700 and 1709 considerable irritation toward their arrogant master Bentley had developed among certain fellows of Trinity College over what they took to be his unwarranted arrogance and repeated infringements on their privileges. The situation steadily worsened so that, in 1710, senior members of the college instituted procedures designed to relieve Bentley of his position. These culminated in an indecisive trial before the Bishop of Ely. Finally there was a definitive sentence in 1714, and it was to "remove Richard Bentley from this office of master of the college." The death of the bishop, the death of Queen Anne, and a press of political events somehow prevented the imposition of the sentence. The remaining twenty-eight years of Bentley's tenure were, if anything, even more

tempestuous, with repeated attempts made to unseat him at Trinity and even to deprive him of his university degrees. Bentley's temper and tactics may well have been reprehensible, but it seems quite clear that he had a higher conception of the college and university than did the senior members of the college. Although his detractors were many, he was not without supporters, particularly among the younger fellows, led by Jurin and Cotes. Moreover, he had over the years drawn many distinguished scholars from outside into his own intellectual circle including, for example, Sir Christopher Wren and John Locke.

In using the university press at this base personal level, Bentley sought to marshal evidence that could be taken as attesting to his lofty character, his high-minded principles, and his dedication to all that is true and good, through the instruments of endorsement and praise in the dedicatory and prefatory remarks in the books issuing from the University Press under his sponsorship. It is in this context that the effusive and exuberant praise, excessively lavish and generous even by the unrestrained standards of the early eighteenth century, of Jurin's and Cotes's prefaces and dedications are to be understood. Their remarkable similarity and specificity suggest very strongly, along with other evidence, that the two prefaces must be regarded as neither spontaneous nor unrehearsed and raise the question of the strength of Bentley's own hand in them.

The translations into English offered below of the Latin of James Jurin's Dedication and of the Preface to the Reader of his Appendix to the *Geographia Generalis Varenii* (1712) is the first such translation to appear (to the best of the author's knowledge). The translation is deliberately very literal.

DEDICATION
to a Man, named
at once an Ornament and
an Envy in his own Age
RICHARD BENTLEY,
S.T.P.
of the Sacred Household of her
Royal Majesty,
Custodian of the Royal Library,
Archdeacon of Ely,
Master of Trinity College at Cambridge.
Greeting

This effort, O Most Preeminent Man, although I weigh its insignificance carefully to myself and am ashamed to say was undertaken by your auspices and encouragement, I, nevertheless, insist upon inscribing, not at all meekly, to your Name. Of course, I know, in fact that You do not reject efforts of any kind whatever for the promotion of literary affairs, so that you comprehend or rather specifically take note of all such things with a most well-disposed fondness. For in fact, you who indulge yourself in these disciplines and judge your spare hours not otherwise to be used more felicitously, have, in fact, expounded the extraordinary use of these things not only in Physics but also in Theology itself almost from the first; indeed, you support the diligence of others in things either to be learned more or to be augmented; thus you support the industry of others in these things either for extending their own learning or for increasing knowledge; and thus you have caused advancements to be made toward unusual zeal in the scholarship of the Youth of this University of Cambridge by struggling against Ignorance, by resisting Jealousy, by approving all Good Things, by Your Authority, and by your own outstanding Example; whatsoever of this kind Alma Mater is about to bring forth, it ought to adopt no other patron besides You, and be seen to claim to itself your patronage as though by a law itself.

May it be permitted, therefore, O Most Illustrious Man, since not all of us can be highly esteemed, that by this service I have secured grateful disposition towards You for the greatest acceptable benefits to be vouched for in public; and that the College indeed, that is, as it were, the Common Home and second Mother of all of its alumni, of whatever perversity, may become convinced to congratulate you for its most excellent and wholly unbiased administration; and at last to proclaim its utmost respect, concerning your worth. And as is proper, I admire and respect,

You in the name of all,
your most devoted
James Jurin

APPENDIX
by James Jurin
TO THE READER
PREFACE

Because very soon now copies of the Varenius will be sought in vain at Booksellers nearly everywhere and since he has judged that to be a great detriment to the young men of the University whom he governs, not for public reward, but rather with extraordinary learning, labor, faith, sanctity, and wisdom, that Venerable Man,—never to be mentioned by me except with the highest esteem—RICHARD BENTLEY, urged me that I might accept the responsibility of preparing this particular new Edition concerning which he expressed to me the greater opinion that it would be equally good for its own sake and for humanity.

At one time he is devoted to the Good Queen and to the Church; at another he causes even the least part of this Most Celebrated University to be bestowed with zeal. He promotes and adorns it more and more from day to day and makes it blossom forth, and as I may truly say, he compels it. He continues his private studies by which he educates and enriches

the Learned World with tireless diligence. Nor, finally, has that dreadful jealousy of him by his obstructors, by which for a long time now in his uncommonly illustrious and conscientious mind he is afflicted, and which now, happily as I hope, he struggles to surmount and trample down, been able to prevent in the least that he embrace with care those things pertaining to literary matters.

At the same time he fortells a useful future if I were to gather into an Appendix, for the sake of Beginners, those discoveries, and they have been sufficiently many, from the period of more than half a century since Varenius, and if I were to explain them concisely. I have not been able not to comply completely with the authority of so great a Man by whose beneficence I have been embellished to the fullest. And although I saw clearly the risks in such an attempt, I have decided nevertheless to publish these insignificant and immature first fruits of my studies, rather than, considering my reputation, fail in my duty and usefulness to the public.

You have therefore, O Benevolent Reader, those things which, in fact, had been treated by Varenius, but are not now so ready at hand, and which, of course, were lacking the works of the Modern Philosophers. These things from the most excellent of these writings have been made clear and refined in a way that is perhaps my own special contribution. Since I am a keen supporter of brevity, I have given these things shorter explanations than are found in the Authors themselves. However, so that those things may be able to be understood thoroughly and be examined at length without interruption, I consider recommending work to acquire some knowledge of Geometry and Arithmetic both abundant and varied. These things are required also for the Varenius itself to be understood, and which he himself declares to be necessary for students of Geography. He most certainly does not approve of that perverse practice or custom in which Young Men not yet tasting of those two sciences apply their minds to other disciplines of Philosophy. And yet, so that something of significance can be done by the more inexperienced students, I would advise omitting generally the more difficult demonstrations and that either other easier, and, as it were, allied things be added or that the diligent students be referred back to the Authors themselves.

For comparison, the final paragraph of Andrew Motte's translation (1729) of Roger Cotes's Preface (1713) to the second edition of Newton's "Principia" is here given.

> *Newton's* distinguished work will be the safest protection against the attacks of atheists, and nowhere more surely than from this quiver can one draw forth missiles against the band of godless men. This was felt long ago and first surprisingly demonstrated in learned English and Latin discourses by *Richard Bentley* who, excelling in learning and distinguished as a patron of the highest arts, is a great ornament of his century and of our academy, the most worthy and upright Master of our *Trinity College*. To him in many ways I must express my indebtedness. And you too, benevolent reader, will not withhold the esteem due him. For many years an intimate friend of the celebrated author (since he aimed not only that the author should be esteemed by those who come after, but also that these uncommon writings should enjoy distinction among the literati of the world), he cared both for the reputation of his friend and for the advancement of the sciences. Since copies of the previous edition were very scarce and held at high prices, he persuaded by frequent entreaties and almost by chidings the splendid man, distinguished alike for modesty and erudition, to grant him permission for the appearance of this new edition, perfected throughout and enriched by new parts, at his expense and under his supervision. He assigned to me, as he had a right, the not unwelcome task of looking after the corrections as best I could.
>
> ROGER COTES
> Fellow of Trinity College,
> Plumian Professor of Astronomy
> and Experimental Philosophy
>
> Cambridge, May 12, 1713

The two translation styles do differ in their degree of literalness but even so they support the idea, which is even more apparent in the original Latin versions, that the two young scholars were in unity and concord—or was it collusion?—with their superior and mentor at Trinity College. If the accord were as strong as the protestations of it, then this small but united band of Newtonians might well weather the tempestuous ragings of the majority of the other Fellows.

The crux of the matter concerning "Newton, the Newtonians and the *Geographia Generalis Varenii,*" however, is the actual content of the Appendix to the work as compiled and interpreted by Jurin for the 1712 edition.

In all, Jurin gave forty-six citations of "new" and "modern" authors drawing most heavily upon Newton, Halley, and other Newtonians such as Francis Hauksbee, Newton's assistant and general factotum at the Royal Society. Others whose weight of evidence Jurin amassed to use in his discharge of his appointed task included such stalwarts as Gregory, Flamstead, Boyle, Ditton, Bernard, Lowthorp, and Woodward. The additional continental sources included Huygens, du Hamel, Hayes, de la Hire, Couplet, Bignon, Cassini(s), Fontenelle, de Chasel, Richer, and Torricelli. The most frequently cited journals were the *Philosophical Transactions of the Royal Society* and the *Histoire de l'Academie Royale.*

Jurin retained all of the thirty-three illustra-

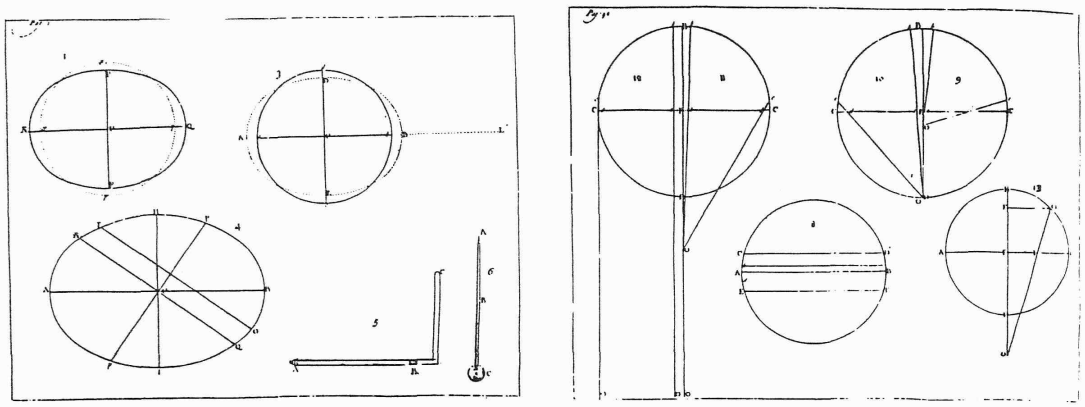


Figure 16. The new figures contributed by James Jurin in his appendix to the 1712 edition of the *Geographia Generalis Varenii*.

tions as presented by Newton, redrawing one of them (for reasons which this present author cannot as yet offer an explanation). Thirteen additional diagrams were added by Jurin in the Appendix (See Fig. 16). The three ancient wind tables introduced by Newton were retained but the discussion of winds in the Appendix transcends these.

Jurin was very careful in his annotations and documentations, and, in his 1712 edition, the method of citation employed was essentially that employed by scholars today.

Both Newton's "Principia" (1687) and his *Opticks* (1704) were drawn upon heavily concerning the Figure of the Earth as an oblate spheroid and the reasons for it. As well, Jurin involves the "Principia" in a very long discussion aimed at destroying the "Cartesian's vain contrivance of Vortices to explain the tides" in favor of the more agreeable Newtonian one including contributions also from Halley and Gregory.

Although the elementary purpose of the Jurin work is to supplant Cartesianism with Newtonianism, it is never allowed by Jurin to assume any of the proportions of a diatribe. Descartes is treated with respect as an important historical personage who made many lasting and valuable contributions. The matters of recognition and attribution are handled gracefully and much of the contribution can be seen as a successful attempt to update, refine, and augment the learning of Varenius.

Bernard's corrections are included concerning the proportions among the English, French, German, and Roman foot.

The knowledge gained by the French concerning the magnitude of the earth's circumference in their triangulations on a base line from Amiens to Malvoisine and the extension from Paris to the Pyrenees Mountains is precisely described and elaborately graphed (see Fig. 17a). Cassini's generalization from these empirical observations that the earth must be a prolate spheroid (as against the oblate one deriving from the theoretical considerations of the Newtonians) is tactfully explained as resulting from France's intermediate latitude where observations really would not reveal overwhelming evidence of the true oblateness. Nonetheless Jurin did involve the "Principia" once more.

Varenius's concern and explanations about "why the ocean is not enlarged when it receives so many rivers" are enhanced by Halley's remarkable conclusions based on his estimates of the operation of the whole hydrologic cycle in the Mediterranean Sea Basin.

Similarly, Varenius's statement that "Air is not light but heavy, considered absolutely" is used as the basis for an extended discussion of the Torricellian experiments with the barometer. Evangelista Torricelli's (1608–1647) experiments were conducted in 1643 and the results presumably would have been available to Varenius in Amsterdam in 1650. Varenius does not cite Torricelli specifically but Varenius's state-

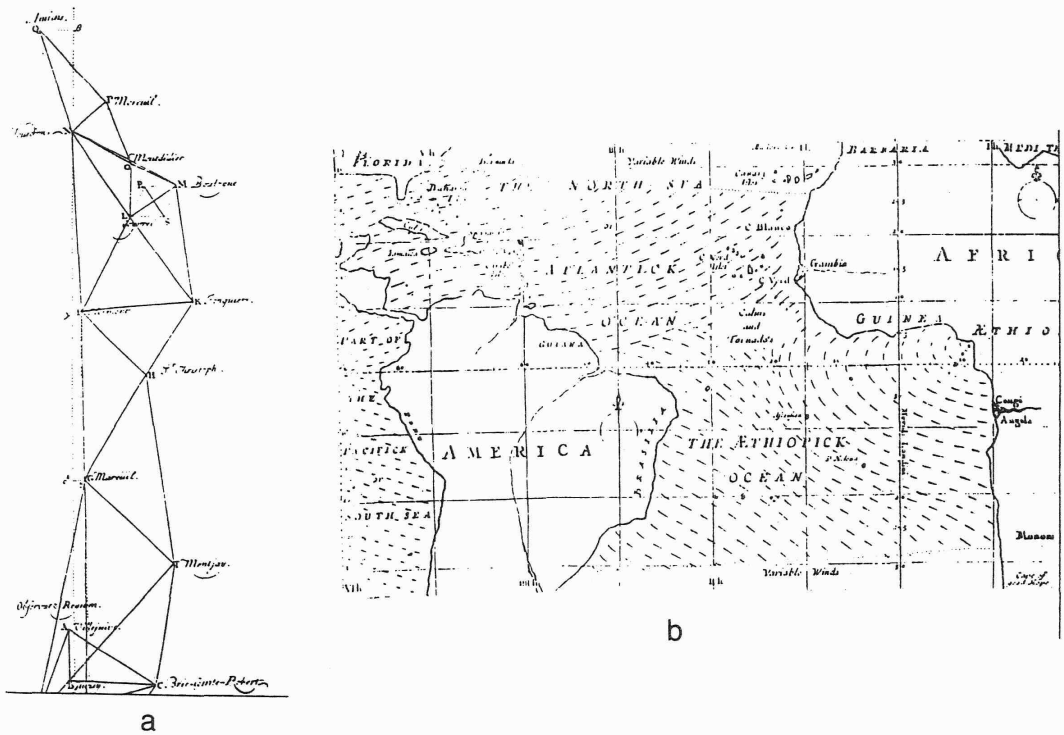


Figure 17. (a) Part of the graph of the "Amiens to Malvoisine Triangulation" and its extension from Paris to the Pyrenees Mountains, included by Jurin; (b) Part of Halley's Trade Wind Chart. Jurin discusses Halley's view on terrestrial patterns of constant and periodic winds.

ments are not inconsistent with his findings. Newton in 1672 and 1681 chose not to enlarge upon the matter. The "modern" findings discussed by Jurin include those of Hauksbee and especially the definitive ones of Robert Boyle. A large number of additional experiments performed in England, France, and Italy are mentioned. It is recommended to the students that they see the works of Gregory and Halley. Cassini, Fontenelle, and de la Hire are also offered as reliable sources.

Additional detail is given about the improvements that had been made to those thermometers described by Varenius and the discussion of refraction of light rays as related to density of the atmosphere benefits from Jurin's consideration of the experiments by Lowthorp and the more accurate ones performed subsequently by Hauksbee before the Royal Society. This in turn is related to the field experiences of the Dutch who had wintered in *Nova Zembla* and the French in the Pyrenees.

Halley's Chart of the Trade Winds (see Fig. 17b) and his very lengthy discussion of these winds and their relation to the possible entire terrestrial pattern of constant and periodical winds is given by Jurin. The descriptive geographical detail given by Halley is remarkable as it is incorporated by him into the more general systematic framework not accomplished by Varenius.

Varenius's treatment of the Paradox of two Summers, two Springs, but only one Autumn and one Winter in a perverted order (Spring, Summer, Spring, Summer, Autumn, Winter) for places between the equator and the Eighth Degree of North or South Latitude based on the Sun's apparent approaching to and withdrawing from their Zenith is rendered easier to understand by Jurin who in this instance drew upon the explanations and graphs derived from Humphrey Ditton.

The problems of determining the longitude, particularly at sea, were reviewed extensively

by Varenius, and thorough treatment of the various methods suggested for finding it up to the mid-seventeenth century also was given by Varenius in what is still a useful statement. Jurin's only concern with the Varenius statement is to consider the advantages and disadvantages of the "Sixth method of finding the Longitude: by Clock-work." Varenius had discussed this only in general terms of the relationship and the magnitude of the problems that would result from the inadequacy of faulty clocks. Jurin gives his own contribution a particular Newtonian cast by discussing the varying Latitude effect, i.e. the varying gravitational effect, on a clock (presumably a pendulum one). Apparently, at that time, Jurin was unable to see the possibilities (later developed, of course) beyond the pendulum clock. He follows this with a playful consideration of what he calls the "French Dilemma." With their own observations by Richer, Hayes, and Couplet, they are "required to use an Hypothesis which they themselves do not at all regard as consistent."

Jurin did include an additional table of Latitude and Longitude of Places. He also improved on the original one by Varenius as already revised and corrected by Newton in the body of the work. In his new table Jurin gave recently determined sets of coordinates for 152 more places and this time with the Prime Meridian taken as passing through London (St. Paul's). An improved table for 1710 A.D. of declination and right ascension for the thirteen stars of the greatest magnitude was provided by him as well.

The important topic of map projections came under Jurin's scrutiny as well. He made extensive revisions and additions to the Varenius treatment of the various perspective and non-perspective mathematical projections developing much more fully small corrections introduced by Newton. Jurin's discussion and graphs neatly summarized virtually everything known about the nature of projections at that time. Perhaps one can even see a glimmer of the major issues in the exclusive and inclusive properties of various groups of projections not resolved until more than sixty years later by Lambert.

The earlier knowledge of the magnetic compass, its history, and its use had been reviewed by Varenius. Halley's monumental work on terrestrial magnetism including his Chart is now reviewed and analyzed here. Halley's now quaint but imaginative theory of the causes of variations in terrestrial magnetism receives full treatment by Jurin. Although the features of Halley's Chart of Terrestrial Magnetism are fully described and the geographical patterns it shows are detailed, the Chart simply was not included for publication. This is particularly odd given the great importance of the Chart and especially the fact that it was noted as desired specifically by Cotes in his letter to Halley on behalf of Jurin that he "might have your leave to annex some of your treatises to his edition of Varenius's Geography" (Cotes 1710/11, 204-05). The fact remains. The descriptions and discussions of the Chart of Magnetic Variation were there in the Jurin edition. The Chart, itself, was not. We have now in this paper come full circle to the Cotes correspondence with Halley. Only a few additional remarks remain to be given.

Conclusions

It can be said fairly that Jurin succeeded in the task set for him by Bentley. After 1712 the *Geographia Generalis* could be read as an expression of Geography by the Newtonians incorporating their own findings and meeting the requirements of the more exacting standards of their developing science in general.

James Jurin went on to fame and fortune as physician, scholar, and international celebrity in the cause of Newtonian science. Doing the research for the revision of the *Geographia Generalis Varenii* must have been among his useful preparatory exercises.

Both Richard Bentley's general and his very special and particular needs seem to have been well served.

Newton and Halley were always interested in the many topics relevant to the work. In fact the table of contents of the *Geographia Generalis* might well be used as representing categories under which many of their life-long far-ranging interests and concerns might be classified.

The Cambridge Cartesians were replenished and could be and were satisfied in continuing their ways by using the new edition selectively by ignoring the Jurin Appendix.

Roger Cotes, unfortunately, died prematurely in 1716 but not until he had made a monumental contribution to the second edition of

Newton's "Principia." Included in the Trinity College, Cambridge, holdings of the books, letters, notes, and papers of Cotes is his own personal copy of the 1712 edition of the *Geographia Generalis* given to him as a gift to a friend by James Jurin. The intriguing thing about Cotes's copy is that there are many additional corrections, additions, and references handwritten into it in ink by Cotes almost as though he were preparing for, or at least considering, yet another revised edition of the work. Perhaps such procedures were only part of Cotes's routines of scholarship; he treated the work seriously. And, certain of the records of the Cambridge University Press actually do list an edition beyond the Jurin one of the *Geographia Generalis Varenii*. It may be safely stated that it was not published. However, the many loose ends urge one to further research.

It can be concluded that the *Geographia Generalis* commanded significant concern and respect from Newton and the Newtonians. Their attention to it was not aberrant or spasmodic but an integral part of their concerted thrust in science.

The *Geographia Generalis Varenii* in its Jurin edition was rendered into English in a very free and selective manner with some exclusions and many more "Newtonian" additions in 1733, as noted above, by Dugdale and Shaw. Peter Shaw, in particular, was a thorough-going Newtonian, and it was he who took the lead in this effort. The work (and its subsequent editions) proved to be remarkably influential not only as before in the two English universities but also in the American colonial colleges, where it assumed special importance in the curricula and helped to shape the ideas and attitudes in education later invoked by the founding fathers of the new republic. But that's another story (see Warntz 1981).

In fact, even today the strong effects of the *Geographia Generalis Varenii* are upon us. Along the way the gaps and defects were filled and corrected. It became accoutred and equipped with appropriate graphs, tables, and charts. Its science has been emended, corrected, improved and expanded, subdivided, partitioned, and dissected, merged, synthesized, and coalesced, destroyed and recreated in new forms, but most of all utterly surpassed in extraordinarily novel and imaginative ways, yet the rational skepticism embodied in it and the form of its organization remain to guide studies to this day in influential places even though the direct lineal descent of revised editions has long since died off. It may be comforting to Geographers and others, who may cite, praise, and invoke the authority of the various *Varenii* without studying or reading the classics themselves, to know they are on safe ground.

Acknowledgments

The author wishes to express his gratitude for the support of his research at critical junctures by the Social Sciences and Humanities Research Council of Canada and the University of Western Ontario. Much of the work was done by the author at Cambridge University. He is also very much in the debt of Clare Hall College there, where as a sometime Visiting Fellow and Life Associate, he received every good advice, assistance, and encouragement in his continuing research. Defects, shortcomings, superficiality, and inconsistency in the work are entirely the author's own contrivance and his responsibility alone. They derive entirely from his inability to make full and appropriate use of the opportunities so amply provided by so many individuals and institutions.

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Notes

1. Cotes refers to himself in this way. In other places the Plumian Professorship is said to be of "Astronomy and *Natural* Philosophy."
2. The letter is not dated, "but the circumstance of its being written upon the same sheet of paper" as the letter preceding it (26 or 27 December 1710), and the one following it (15 Feb. 1710/11) "shows that it is separated by no long interval from them." This date is consistent with the publication records of the Cambridge University Press. For the detailed schedule of production (1710–12) of "Jurin's edition of Varenius's Geography" see McKenzie (1966, Vol. I, p. 340, Item 250).
3. These graphs (Figs. 2–6) and the subsequent maps

(Figs. 7–9) are part of a larger project conducted by the author at the Center for Population Studies, Harvard University, in 1983–84. The full documentation of Warntz's extensive but unpublished work on this project is available in the Regional Science Archives, Cornell University, Ithaca, New York.

4. Price (1961) recognized the general applicability of a logistic curve applied to the growth in the number of European universities and concluded that saturation (without the rejuvenating influence of movements like the Reformation and counter-Reformation) of the medieval-type university would have occurred at a total of 80 universities.
5. Christiani's *Systema Geographia Generalis libri duo absolutum* (1645b) has been confused by Lebed'ev, says Lange, with Christiani's *Disputatio de Triplici Mundi Systemate Ptolemaico, Copernicano et Tychonico* (1645a). I am indebted to Professor Owen Gingerich of Harvard University, who, in personal correspondence, has called the author's attention, with several examples, to seventeenth-century general iconographic practices that would seem to cast the vote toward the "mighty three." Yet, Galilei (1632) substituted his own head on one occasion on an otherwise conventional depiction of Copernicus, thereby putting himself in the company of Ptolemy and Aristotle. Apparently although conventional representations of the historical personages were widely used, individual identifications with them by modern authors also occurred.
6. The preserved correspondence of Varenius consists of only nine letters to Joachim Jungius (1587–1657), his earlier mentor (and several more implied ones to Jungius and Tassius) and date from 1643 in Königsberg to 1648 at Amsterdam and include letters also from Leiden. They exist in their original Latin form in the collected correspondence of Jungius as published in Ave-Lallemand (1863). Drafts of some of Jungius's carefully prepared responses fortunately are also available in the same collection. German translations in a not altogether faithful (and frequently so selective as to be misleading) fashion do exist (Guhrauer 1850). No English translations exist. Warntz attempted Latin-to-English translations and an *apparatus criticus* as well for the Varenius letters and the Jungius draft responses. These translations are available in the Warntz Collection of the Regional Science Archives at Cornell University.
7. The first and second Newton edition of the *Geographia Generalis* referred to Varenius on the title page in the genitive form as *Varenj,* causing contemporary librarians in some of the Cambridge colleges to cross reference the work under *Varenus* and so it stands to this day (not an inconvenience, really).
8. Upon examining the list, one might conclude that Varenius regarded as famous places not only the very large cities and the political capitals, but, as well, the university towns, printing centers, and the "historical" places where the great battles of the world had been fought.

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