

THE NOBLEST CRYPTOLOGIST



DUKE AUGUST THE YOUNGER OF BRUNSWICK-LUNEBURG
(GUSTAVUS SELENUS) AND HIS CRYPTOLOGICAL ACTIVITIES

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I) Duke August and His Library

Modern cryptologists are aware of some of their important precursors in the field of cryptology since their names are associated with significant inventions and developments in the area of secret communication. Terms like the Trithemius alphabet, the Vigenère cipher, the Cardano grille, the Porta cipher, the Caesar substitution recall persons whose contributions have survived the centuries and constitute milestones in the evolution of this discipline. One cannot say the same of Duke August the Younger of Brunswick-Lüneburg, whose name has not become a household word in modern cryptology, although he is listed in the bibliographies and handbooks of the trade and was, as a duke, the highest ranking nobleman to deal extensively with the subject. And yet Duke August--or Gustavus Selenus [1], as he signed his scholarly publications--was one of the best-known cryptological writers of the 17th century, although not all of his readers knew what an illustrious person was hidden behind this pseudonym. His Cryptomenytices et Cryptographiae Libri IX [2] of 1624, a beautifully illustrated large quarto tome whose nearly 500 pages constituted the most thoroughly researched compendium written up to then, became the standard reference work of the century.

This compendium nature of Duke August's cryptological work accounts for his relative obscurity among modern cryptologists: Contrary to some of his better-known contemporaries or predecessors such as Trithemius, Vigenère, Porta, Cardano, Schwenter, or Kircher, Duke August cannot be credited with a single important cryptological invention; his sole goal in writing the Cryptomenytices was to present "the state of the art" as well as explicating the Trithemian methods. As a painstaking researcher and collector of cryptological source materials he performed brilliantly; even our most recent bibliographies prove [3] that there is at most a handful of works published before 1620 that Duke August did not know--and possess.

August the Younger can truly be called one of the greatest and most scholarly collectors of books. Beginning in his teens and continuing to 86, he systematically purchased and accumulated what in a panegyric of 1661 was called "the eighth wonder of the world." [4] At the time of his death in 1666, the Bibliotheca Wolferbyтана or Augusta, as the library was soon to be known in honor of its most eminent contributor, [5] comprised 135,440 titles--among them 2891 manuscripts--bound in 31,298 volumes and mostly catalogued by the duke himself. [6] The immensity of this achievement becomes somewhat clearer when one compares this collection with the famous library of Cardinal Mazarin, one of the most powerful men of the time, for whose wealth the impoverished German duke's was no match and whose collection of books may have numbered about 40,000 volumes at the time and was also hyperbolically regarded "with some justice as the eighth wonder of the world." [7] This Bibliotheca Augusta, the

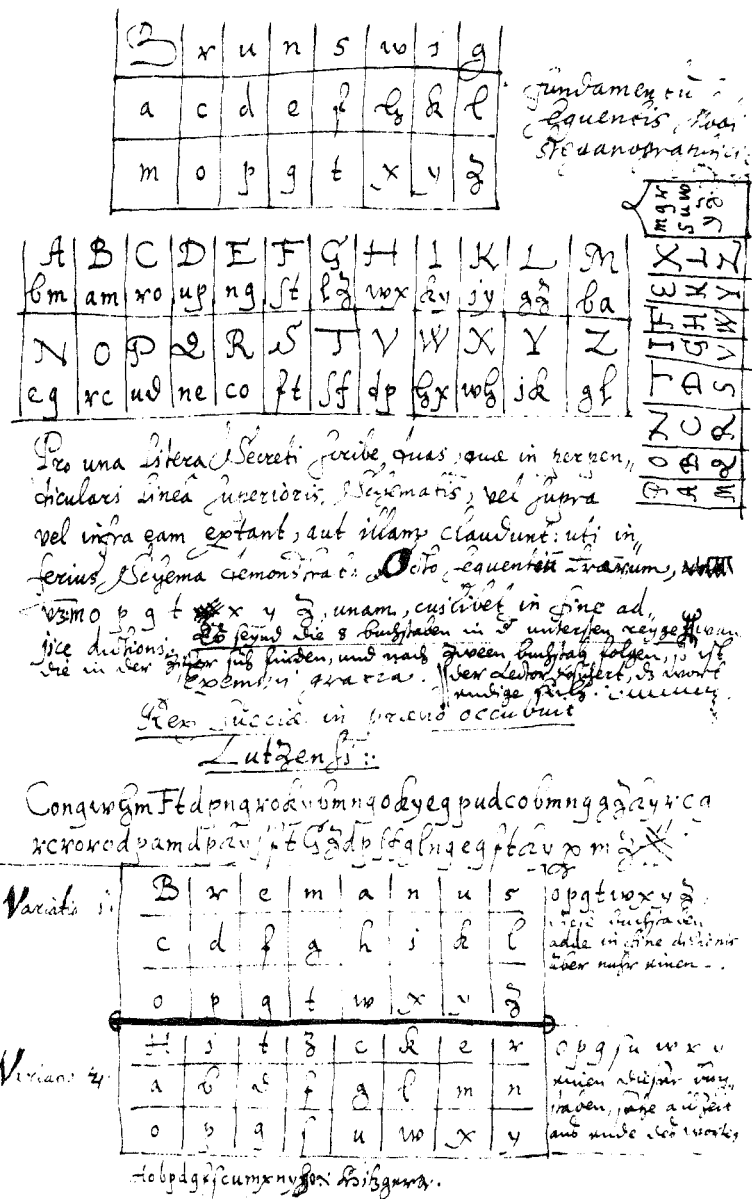


Figure 2. Various substitution ciphers with different key words contained in a collection of materials gathered for the preparation of the Cryptomenytices. The key words are: (top) "Brunswick", (vertically) "Pontifex" (the Pope), "Bremans" (unidentified name), "Hitzcker" (Low German for "Hitzacker", the location of the duke's residence before he moved to Wolfenbüttelel).

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heart of the collection of the modern Herzog August Bibliothek in Wolfenbüttel near Brunswick, has survived in its entirety, still marked by the original classification scheme devised by the duke for "his" library. The system arranged traditional scholarship and knowledge in 18 groups, beginning with "Theologica" and "Juridica." To these 18 were added two more: the "Quodlibetica"--the "unclassifiable" books--and the "Manuscripta." [8]

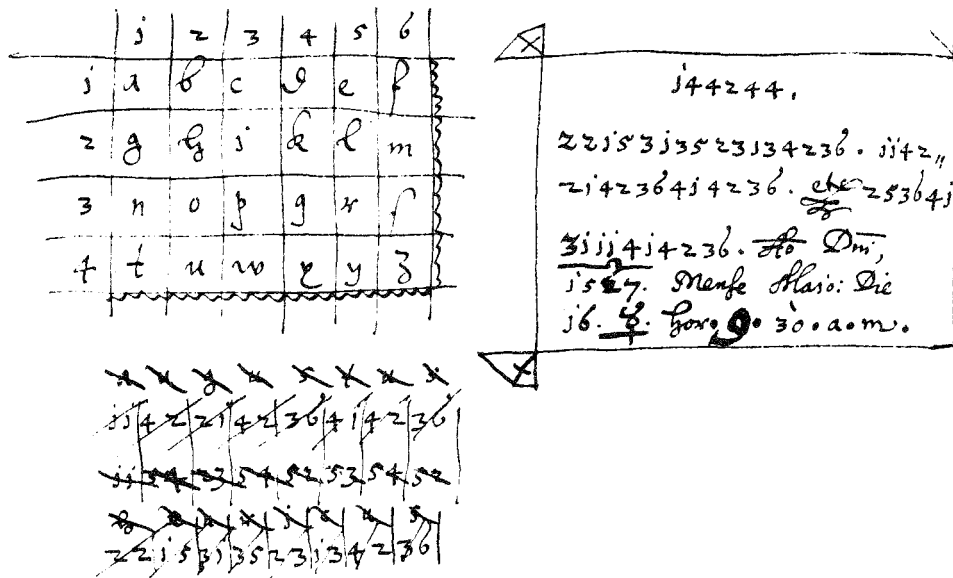


Figure 3. Substitution cipher in Duke August's hand contained in a collection of materials gathered for the preparation of Cryptomenytices. The plain text on the right reads (in Latin): Dux Henricus Augustus etc. 1st (error for est) natus Ao. (anno) Dmi. (Domini) 1527. ... (Duke Henry August was born in the year of our Lord 1527. In the month of May: On the 16th day. (symbol for) Wednesday. At the hour of 9:30 a.m.)

While the duke valued cryptology most highly and considered it a learned art equal to mathematics or physics, he did not create a separate grouping for his cryptological works. This means that the several hundred books on secret communication he collected during his lifetime can be found even today in the disciplines where he thought they most properly belonged, primarily under "Rhetorica," "Logica," "Grammatica," [9] but also "Physica," "Arithmetica," "Bellica," "Historica," and "Quodlibetica." Duke August prefaced his Cryptomenytices with a list of the 187 authors he had used in its preparation. [10]

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While among them are some works a modern cryptologist would consider at best only marginally relevant,[11] these 16th- and 17th-century books and manuscripts in their calfskin or pigskin bindings and their frequent annotations and inserted notes in Duke August's hand constitute the sources for one of the most valuable cryptological handbooks in modern times. Some of these sources, the handbook itself, and above all its author deserve a closer look.[12]

II) Duke August's Life, Studies, and Scholarly Publications

August's father, Duke Heinrich (1533-98), had shared the government of the duchy of Brunswick-Luneburg at Celle with his younger brother, Wilhelm (1535-92), for a decade, when he decided to marry Ursula of Saxony-Lauenburg in 1569. Wilhelm was already married and the father of 3 sons. Heinrich apparently envisioned that his own marriage would ultimately lead to a division of the Guelph lands. The strong opposition of the landed gentry, however, forced him to resign his personal claim to the Duchy of Brunswick-Luneburg at Celle (located in the center of northern Germany, south of Hamburg). As a small compensation, he received the unimportant territory of Dannenberg, which was carved out of the duchy of Brunswick-Luneburg and encompassed some 15 square miles of land along the Jetzel and Elbe rivers together with the castle and city of Dannenberg on the Jetzel. Here he founded the lateral line of Luneburg-Dannenberg.

It appeared that Duke August the Younger, who was born in 1579 as the seventh and youngest child of Duke Heinrich and his wife Ursula, had no hopes of ever gaining any influential position through inheritance. Thus, his parents gave him a longer education than was customary and at places more distant from his home. In 1594, at age 15, he left for the nearby university of Rostock, where he was elected honorary president not only because of his noble descent but also for his academic potential, a distinction which he later received at Tübingen, too, where he continued his education. Although he concentrated on theology, history, and jurisprudence, he was also fortunate to have Michael Maestlin (1550-1631), Kepler's teacher, as his instructor in mathematics and astronomy. Even at this age he was attracted by the more speculative aspects of these two disciplines and studied astrology as well as occult and secret sciences. His diary and notes, which have survived, show him to be an inquisitive and highly intelligent young man. They give the reader a first glimpse of an analytical and positivist mind, which may account for his unusual organizational skills.[14] After four years of study (which, as was customary for the higher nobility, he did not conclude with an academic degree) his parents financed a two-year educational tour of Italy, where he enrolled at the university of Padua. His subsequent travels to Holland, England, and France were of a more practical nature; the young prince without lands first

sought employ as a military advisor with his cousin, Maurice of Orange, the great Dutch military leader, then temporarily held the position of canon at Strassburg before returning home to Dannenberg. Soon after, he settled for the tiny city and county of Hitzacker at the confluence of the Elbe and Jetzel rivers, just a few miles downstream from Dannenberg. On his grand tour of Europe, he had visited the royal library in Paris, the Vatican collection, the court library in Munich, the Leiden university library, the Mediceo-Laurenziana in Florence, and the newly opened Bodleian at Oxford. His diary reflects his immense interest in the collections of books and curiosities he encountered during his travels,[15] and this experience perhaps instilled in the duke, by now 25, the need to fill his secluded life in Hitzacker with more than the administration of a tiny territory and 2000 subjects. Duke August, a strong and imposing young man who always sported a moustache and a pointed beard, married three times and was widowed twice; his second and third wives bore him 8 children, of whom 3 sons and 3 daughters survived him.

It was during the 30 years at Hitzacker (1604-1634) that Duke August laid the foundation for his famous library and devoted a great deal of his daily life to his scholarly activities. Contrary to the image of the Faustian scholar and stuffy librarian that centuries of tradition seem to have established, the duke was not oblivious to the world around him. He travelled a great deal, suffered somewhat from the first half of the Thirty Years' War, and over a period of more than 10 years prepared the legal grounds for his claim to the succession to Friedrich Ulrich, the reigning duke of Brunswick-Lüneburg at Wolfenbüttel, who died without heir in 1634. Since August's father Heinrich had only resigned his claim to the northern portion of the Guelph lands, namely to the duchy of Brunswick-Lüneburg at Celle, Duke August the Younger—after having come to an agreement with his older brother at Dannenberg—had a reasonably good case when the problem of succession to the southern portion at Wolfenbüttel became acute. Yet the creation of his library remained August's major preoccupation, and in 1611 he began writing his first folio catalog which—when completed in 1625—listed 6245 volumes.[16] The redaction of this catalogue coincided with the duke's most productive scholarly years (except for his later theological publications), in which he completed his 1616 book on chess-playing, Das Schach- oder König-Spiel, [17] and the Cryptomenytices et Cryptographiae Libri IX of 1624. The chess manual shows the author's approach: He pursued his avowed goal of making the best use of the sources available to him with the greatest scientific exactitude so that "eine kleine perfection, so viel in hoc mundo geschehen kan, daraus werden möchte," [18] as he wrote to Philipp Hainhofer, one of the book agents he plied with requests for more source materials. As also observed in the later cryptological work, Duke August's Schach-Spiel does not reveal an original thinker. Both in his historical introductions and in the elucidation of the rules of the game he relied primarily on the sources given, and the subsequent explanatory moves

and games were not the result of his own experience or research but were translated from a 1561 manual by a Spanish priest, Ruy Lopez.

Quintus. Cap. 32. 203.
 Caput duodecesimum.
 De Transpositione Obliqua, seu dispositionem Alphabeti.

Tertius Processus huiusmodi Transpositionis, consistit in ^{subinde quatuor} ~~transpositione~~ combinatione Literarum; qua per se pendet ex ~~transpositione~~ ~~transpositione~~ unius Alphabeti, in tabula & eius capitulis inclusis, cuius superiores, Literae valentes, tres vel quatuor, bis in modum norma sive quadra, semel superius & semel a latere sive dextro, sive sinistro apponuntur, eoque fit, ut Literae secretae Sententiae & orationis, apta & legitima ratione, in tres vel quatuor, vel ad summum quinque illas superiores Literas, simul junctas, possint transferri. Cardanus, lib. 2. Variar. lib. 2. El Porta lib. 2. c. 12. sicut & Alij, in, ter quos & noster Vigenereus, huius generis Tabulas confectas, quas eo ordine illustrabimus, ut primo Tabulas & earum rationem, deinde usum proponamus ac indicemus.

	A	B	C	A	B	C	B	C	B
A	a	s	g	p	e	x	u		
B	e	e	g	m	p	f	x		
C	c	f	j	n	g	t	z		

13.

Prima Haec Tabula, a quo Vigenereus in Tr. de Cyphris p. 201. extat. Porta vero d. lib. 2. c. 12. nonnulla ratione superiorum Literarum, hanc sicut & inferiores mutat. Tres enim vel quatuor Collaterales Literas, ad dextrum latus apponit. Sed parum interest, nisi quod isto modo, a Superioris ad Collaterales descendendo, hae vero ab inferioribus, ad superiores ascendendo, scriptum congruamus.

	F	G	H	X
F	a	e	m	r
G	b	g	n	f
H	c	i	o	t
X	d	f	y	u

14.

Secunda Tabula, desumpta ex Vigenere p. 243. b. hanc habet pro, presum, quod veluti in superioribus, tribus Literis ita hic quatuor scribamus, & interior tabula, sedecim tantum Literis consistet quo fit

Figure 4. Page 203 of the printer's copy of the Cryptomenytices manuscript showing substitution ciphers taken from Cardano, Porta, and Vigenère. The two tables are woodcuts from page 254 of the printed book that the duke inserted in the manuscript.

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III) The Cryptological Works Used in the Cryptomenytices of 1624

Although the few original moves that were in the Schach-Spiel have raised doubt as to the quality of Duke August's play,[19] the game of chess must have greatly appealed to his analytical mind and mathematical-logical thinking; we also should not overlook the thrill of winning (and gambling) which the otherwise rather stern young prince certainly experienced and even "tolerated" during his student years.[20] We may assume that cryptology appealed to the same elements in him. Beyond that, however, the voluminous correspondence of Duke August contains excellent examples of cryptographic material not only from his later years as a ruler of Brunswick and Wolfenbüttel (1635-1666) but even from his days at Hitzacker, when certain matters of state required the confidentiality of at least portions of correspondence. Fascination with various theoretical aspects of cryptology quickly gave way to certain "favorite" systems for practical use which, however, were usually quite conventional in that they employed a mixture of nomenclators and substitution ciphers.[21]

The duke's interest in matters cryptological began at least as early as his first student years. Among the books acquired at Rostock in 1594, we find Giovanni Battista Porta's Magia natvralis, a work filled with interesting and sometimes incredible scientific oddities and curiosia. The chapter that the 15-year-old August underlined and annotated most was "De Ziferis," to which he referred in the Cryptomenytices. [22] The duke also possessed the cryptologically more important book of Porta, De fvtivis literarvm notis, vulgò De Ziferis libri IIII of 1563. It provided further material, and the detailed index of the unauthorized 1593 edition that the duke purchased in 1595 in Tübingen may have served as a model for his own convoluted tables of contents.

It is not always possible to date acquisitions to the fledgling library with such precision, but for the purposes of this brief analysis of the Duke's interest in cryptology, the above-mentioned list of authors in the Cryptomenytices of 1624 gives us an excellent means of assessing the collection up to about 1621/22. We are also aided by the fact that the first two decades of the century saw a renewed—and polemical—interest in the works of Johannes Trithemius (1462-1516), which according to the subtitle of the Cryptomenytices [23] finally caused Duke August to intercede on behalf of the much-maligned abbot. While the Polygraphiae libri sex of 1518 was reissued several times in the following 100 years, the older Steganographia—written in 1500—was not published until 1606. Its first two sections can now be interpreted as ponderous camouflage for rather simple vowel-consonant substitutions, while the unfinished third part—which to this very day nobody has been able to understand—may indeed have contained unabashed magical operations that cast a pall over the entire book and, after a renewed controversy, caused the work to be put on the Index of Prohibited Books in 1609.[24] There

is every reason to believe that Duke August acquired Trithemian materials at an early date to keep abreast of further developments. By 1622, he not only owned printed copies of the two works in question, as well as the 1561 French translation of the Polygraphia, but also manuscripts of the two books. He painstakingly worked his way through the text, as his deciphered and annotated copy of the 1606 edition of the Steganographia shows. This also reveals, though, that Duke August could not understand a single line of its third part.

The learned Hitzacker ruler was not the only person to come to Trithemius's aid, although he was the first Protestant to do so. The 1606 publication of the Steganographia was taken by many Catholics in that era of religious wars to be a deliberate Protestant provocation. The condemnation of the book in 1609—which indirectly accused the abbot of black magic and heresy—caused two theologians, the Jesuit Adam Tanner and the Benedictine abbot of the Bavarian monastery of Seeon, Sigismund Dullinger, to respond with religious arguments in support of the work. Duke August, however, was the first to attempt a cryptological explication of at least most of this work as well as of the entire Polygraphia.

Before taking a closer look at the Cryptomenytices, we should sample a few more of its sources in order to gain further insight into its composition. By 1622, not only did Duke August possess the standard works of Vigenère, Cardano, or Porta, he had also ferreted out such minor books on cryptology and universal languages as the Opvs novvm published in Rome in 1526 by the Florentine Jacobus de Silvestris. The work of yet another Italian, the Scotographia of 1593 by Abram Colorni, "Jew of Mantua," as he called himself, seemed to the duke so important that he devoted a full 60 pages to Colorni's substitution system, whose publication several diplomats are supposed to have tried to prevent in vain.[25]

When one takes into consideration the diverse sources that Duke August used from disciplines which a modern cryptologist would not even remotely associate with secret communication, it seems obvious that he must have contemplated the publication of his compendium for years. He found runic alphabets and inscriptions that could be used for cipher purposes in a description of north German palaces and books. A combination lock whose six cylinders can only be opened when one discovers the correct letter sequence and gives rise to a discussion of cryptanalysis is reprinted from Johannes Buteo's 1560 book on Logistica, quae et Arithmetica vulgò dicitur. [26] One of the most surprising sources is a collection of "Ten Fables on Mankind" (Decas fabularum humani generis) of 1609, in which Johann Walch also treats the invention of printing, sympathetic inks (and here is where the duke's marginal comments begin), and the vast variety of codes, grilles, and ciphers. The duke gathered historical material from theological, legal, and classical sources—for example, from an

appendix on the Kings of Frisia in a law book he drew what were believed to be hieroglyphic signs of a kind similar to those that Porta had first used for cipher purposes.

One may take it for granted that the north German ruler was familiar with the fledgling German cryptological literature; he owned the first and second editions of Daniel Schwenter's Steganologia, which the Altdorf university professor published anonymously between 1610 and 1620.[27] He refers more than 30 times to the first edition alone, and in some instances examples of secret communication helped by "natural magic" are handed down from one author to another, such as the famous method of "telecommunication by pin-pricks" that can be traced from Porta via Schwenter to Duke August, Kaspar Schott, and to Athanasius Kircher's Polygraphia nova of 1663, where it is finally presented as a "ridicula machinamenta." [28] It should not surprise us to find such a mixture of fact and fiction in serious publications of the 17th century. It was a time of transition in the world of science, a period in which serious and educated men still believed in ghosts yet which also saw the rise of learned societies such as the Accademia Secretorum Naturae (of which Porta was a founding member) or later the Royal Society in England, to which important linguists and cryptologists belonged. Authors like Frantz Kessler published "Various Secrets" (Unterschiedliche [...] SECRETA), a collection that comprised early forms of "water harnesses" and "air hoses" (diving bells and suits) as well as quite sensible plans for optical telegraphs which used a sort of sextant in connection with a telescope to locate messages flashed over sizeable distances by means of signs or torches. This "secret" transmission is, of course, what most interested Duke August.

There is little cryptological material published before 1620 that the author of the Cryptomenytices did not know. Only later did he acquire Samuel Zimmerman[n]'s Etliche fürtreffentliche Geheimnussen [...] of 1579, the first cryptological work in German, which remains little known. There are further omissions, to be sure, and the weakest part of Duke August's cryptological knowledge is perhaps his lack of material from the British Isles. He knew of Roger Bacon's ciphers from fragments in his alchemical writings, and he reprinted Thomas More's "Utopian" alphabet from the 1518 edition. Sir Francis Bacon's thoughts on the subject, however, and the biliteral cipher that he first published in his Advancement of Learning of 1623 remained unknown to the duke until much later in his life and may be taken as an indication of his relative lack of information on the state of cryptology on the British Isles, in part due to the lack of an agent systematically covering their publications. Nonetheless, this shortcoming must not be allowed to detract from the enormous achievement of the scholar-prince who, tucked away in a remote corner of northern Germany, had managed by 1622 to accumulate and analyze almost two hundred books on the subject of cryptology alone.

IV) The Cryptomenytices et Cryptographiae Libri IX

Duke August worked on the manuscript and the printer's copy of his book from 1621 to 1623; early in 1624, he drafted a dedication to the English King James I, one of the few ruling heads of state to publish scholarly material. In it, he praised James's learned publications, which he made sure to purchase, and recalled his own participation at the King's coronation in 1603.[29] But he later reassigned the dedication to the Holy Roman Emperor Ferdinand II, whose aid he sought in the matter of the Wolfenbüttel succession. The author stressed the practical use of his work, which offered numerous systems and choices to the knowledgeable user, more in the dedication than in the book itself. The preface states that the duke had originally planned only an elucidation and illustration of the Steganographia of Trithemius, but this task soon revealed the need for a systematic analysis of the entire field of cryptology.

This took the form of a historical overview that progressed from very general material to more specific methods and systems. It fills the first two books and prepares the ground for the explication of the Steganographia in Book III. As if to prove that he has largely mastered the three parts of this tome, he completely reorganizes the Steganographia and then very smoothly works his way through the many "magic" formulas that were intended to cover up the basically simple vowel-consonant substitutions and the variations on a system in which only certain letters of "magic" incantations and conjurations (or "nonsense words," as David Kahn calls them)[30] signify the meaning, while the other letters are nulls. With the help of the separately printed—and rare—Clavis Steganographiae, Duke August manages to explicate all but the 12 methods presented in the last chapter of Book I of the Steganographia, for which no keys were given in the Clavis. These 12 methods were omitted altogether in the 1621 edition of the Steganographia but were a feature of the 1521 manuscript the duke owned. Puzzled by the omissions, August thought that perhaps someone unversed in cryptology later inserted this unauthorized material since several of these formulas indeed make use of methods employed by Trithemius in previous chapters.[31] But since the Duke assumes that a number of his readers who owned the 1621 edition cannot—in view of the omission—judge by themselves, he reprints this entire chapter without further comment.

This was also the approach he took when he reached the unfinished third book of the Steganographia. The duke's working copy, the 1606 edition that he heavily annotated in Books I and II, is virtually untouched in Book III, and he readily admitted that he did not comprehend it, citing its incomplete state and claiming that at best it would belong to the field of "synthematology" or telepathy. Trusting that his readers could not decipher the material either



G. S. Cryptomenytice et Cryptographia:
 In qua et planissima Steganographia
 Joh. Trithemii Enodatio tradit et
 Lunsel. ingenio deo Theron, in folio.

but wanting to give them access to it, he went ahead and reprinted the third book verbatim on pages 160 to 180 of the Cryptomenytices. And indeed he was right all along: To this day nobody has explained these pages filled with planetary conjunctions, angels, and spirits, and it may well be true that this third part of the Steganographia is in fact "a treatise on demonic magic" under the thin disguise of cryptological material.[32]

It is only logical that Duke August would want to discuss Trithemius's later and more accessible cryptologic work, the Polygraphia of 1518, in Book IV of his compendium. He easily explained the abbot's system with which a text could be enciphered by selecting words from consecutive columns. The cipher-text then resembled an innocent prayer. In order to illustrate the system in a more manageable way (Trithemius had written out hundreds of columns), the duke first used 57 lists taken from Porta and then reduced his model to a mere 14 lists in German which, however, forces the encipherer to reuse the lists if the plaintext is longer than 14 letters. Adhering to the organizational scheme of the Cryptomenytices, August then postponed a discussion of the polyalphabetic square table or "tableau" as well as of the concluding examples of ancient cipher alphabets until later in his book.

When one looks back at the analysis of the two cryptological works of Trithemius by Duke August one immediately realizes that his was the most thorough—and accurate—treatment up to this date. Books III and IV of the Cryptomenytices served as a starting point for further analyses throughout the seventeenth century and even later.

The remaining portions of this book (V-IX) go back to the more detailed historical overview of the material developed after Trithemius, with which Book II began. In the true manner of a compendium the author frequently traced a method through various works and then picked out the most relevant example. He proudly represents all sorts of ciphers—including musical ciphers hidden in a composition he specially commissioned—and then discusses methods of "concealment" of syllables and entire words, which lead to various forms of codes. Book VIII illustrates the diverse methods of steganography,

(Opposite page)

Figure 5. Printer's copy of the title page of Duke August's Cryptomenytices, with title inserted in the author's hand. The illustrations on left, top and right show — as the duke ordered his engravers — how letters are sent by foot, by water, and by horse. The bottom engraving shows the duke holding a miter over the head of the abbot Johannes Trithemius, whose work August was defending from charges of magic.

from the Greek scytale to sympathetic inks. The last book provides exercises and includes a systematic discussion of cryptanalysis that is influenced by Porta and Schwenter.

Despite its lack of originality, Duke August's Cryptomenytices became the standard manual and reference work for the next two or three generations of cryptologists. The size of the edition is not known, but the author made certain that the important courts and individuals with whom he was acquainted received copies, and the work can still be found in a surprising number of libraries. Only one year after its publication in 1624, the compendium was praised effusively by Gabriel Naudé, librarian and later curator of the collection of the great French statesman, Cardinal Mazarin. Naudé's comments on the Cryptomenytices, in which "Gustavus Selenus" was credited with having removed the odium of black magic from Trithemius's books by revealing their cryptologic systems, show that the duke's manual was known in Paris the year after its publication. The remarks are to be taken very much at face value, for Naudé did not discover the princely author behind his pseudonym.[33] Duke August's work was used both at court and in less noble circles: It was frequently consulted by Count Otto von Schwerin, privy councillor to Frederick William, the "Great Elector" of Brandenburg,[34] and it was used for cryptological purposes by Etienne Polier, as we know from a letter that this Swiss "informant" wrote to Samuel Hartlib, a London scholar, in 1655. The spy offered Hartlib secrets from the French court and asked whether he wanted to use a cipher of his own or one taken from the book by "Gustavus Selenus," "who treated the subject masterfully." [35] This is the practical application that Duke August had referred to in his dedication, which he had never stressed in the work itself, however, partly because he feared such "misuses" by men like this informant, and partly because he wanted his book to be a gateway to the "art" of cryptology, as he called it, and expected his readers to continue their studies beyond the Cryptomenytices. [36]

V) From Scholar-Prince to Reigning Duke of Brunswick-Lüneburg at Wolfenbüttel (1635-1666)

Although Duke August had to be content with his secondary position and the 30 years of "residence" in the small town of Hitzacker, he actively pursued a course of action to gain the duchy of Wolfenbüttel. Once again the characterization of just a bookish scholar-collector that has been attributed to him over the centuries needs to be corrected when one considers the well-planned political steps that he took at Hitzacker over the years. Faithful to his earliest "motto" or device, Expende, or--freely rendered--"with circumspection," [37] he made appropriately-timed visits to the imperial court at Vienna, corresponded exhaustively with various legal advisors, and astutely changed the dedication of his Cryptomenytices. Important sections of the

correspondence of those years had to be enciphered, of course, and several nomenclators of the time have survived in the duke's papers. In 1635, August finally gained the duchy of Brunswick-Lüneburg at Wolfenbüttel when his cousins of Brunswick-Lüneburg at Celle agreed to hand over the southern portion of the Guelph lands to him in order to forestall an imperial seizure of the Wolfenbüttel duchy. Although Brunswick-Wolfenbüttel was the smaller and in many ways poorer part of the Guelph territories, August still profited tremendously. His territorial gains were enormous. In addition, he now shared with his Lüneburg-Celle cousins the administration of various mines in the Harz mountains, of the university in Helmstedt, and of the city of Brunswick, the cultural and commercial center of his new duchy, which lay some 10 miles north of Wolfenbüttel.

The Thirty Years' War (1618-48) had not spared Duke August's new territory; in fact, the Catholic troops of the Holy Roman Empire occupied the administrative capital of Wolfenbüttel from 1627 to 1643, when the new ruler could finally—and solemnly—enter the city after having resided in Brunswick between 1635 and 1643. When one regards the life expectancy in the seventeenth century—little more than 30 years—it is astounding to consider what a task the 55-year-old ruler of Brunswick-Wolfenbüttel undertook to do. With the aid of capable chancellors and advisors, the duke organized and reorganized just about every aspect of public life in his realm, from schools and schoolbooks to the governance and liturgy of the churches, to the various courts of law and even down to taxes on farm produce. Although the image of an absolutist ruler emerges, Duke August remained far from insisting on the God-given powers of a prince and emphasized the "dictate of Reason" that he followed.[38] The Wolfenbüttel lands benefited from the peace the dukes of Brunswick-Lüneburg (Duke August among them) had concluded with the Holy Roman Emperor Ferdinand III in 1642, and life at the Wolfenbüttel court began to flourish. The learned duke attracted a number of Protestant theologians and surrounded himself with scholars from diverse disciplines who frequently came from the territorial university of Helmstedt: As a member of the "Fruchtbringende Gesellschaft" (the "Fruitbearing Society") modelled at the Weimar court in 1617 after the Italian academies, August made his residence a center of linguistic and poetic endeavors in Germany second only to Weimar.[39]

Duke August, who as time passed became the "first among the German princes" not only in age but also in esteem, continued the systematic expansion of his substantial library and even personally entered and described his acquisitions until 1648/49 in his folio-size catalogue, which reached 3692 pages in his hand.[40] Throughout central Europe, his reliable network of agents provided him with new books or searched for missing titles. While such purchases were kept up throughout the war years, publication in cryptology fell off, doubtlessly caused in part by the printing of the Duke's own manual, which seems to

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have fulfilled the needs of the next 20 or 30 years and to have captured the market. In 1650, however, a highly interesting correspondence set in between the German Jesuit, Athanasius Kircher (1602-80), who spent most of his life in Rome, and the Wolfenbüttel ruler. It was to continue to his death in 1666 and involve the aging August one last time with secret communication.

Kircher, who is known among cryptologists as the author of the 1663 Polygraphia nova et vniversalis, was an eminent linguist and mathematician and one of the famous "universal scholars" of the 17th century. Initially, Kircher seems to have sent the Duke his beautiful two-volume musicological treatise of 1650, the Mvsurgia vniversalis, and the ensuing correspondence centered primarily around book requests from Duke August. From 1661 to his death, however, the exchange of letters—triggered off by Kircher's submission of a detailed manuscript of a universal language scheme—concerned mostly linguistic matters and questions of cryptology, which were intimately related with proposals for a world language. When Kircher's Polygraphia nova arrived at Wolfenbüttel in the summer of 1663, Duke August virtually disregarded the first part of the book, a reworking of the earlier universal language idea, but he thoroughly analyzed the rest of the folio volume since it contained the application of Kircher's linguistic methods to the field of cryptology. A note in one of the two Wolfenbüttel library copies of the Polygraphia, written in the hand of the old duke, whose sight was severely impaired, states that he had "written this [a cryptographic exercise based on various methods suggested by Kircher's book] by [candle] light at 10 p.m. on Aug. 16, 1663, at age 84 1/3 years." [41] There later followed an astounding exchange of letters containing, among other things, a laudatory poem by Kircher that was clothed in "magic squares" totalling 144 fields and occasional requests for cryptological clarification on the part of the duke. The correspondence also documents, however, the generosity of Duke August, the maecenas of scholars, who financed a great deal of Kircher's research in the 1660's, in particular after the imperial subsidies that had assured much of the Jesuit's independent work ceased in 1663/64. [42]

(Opposite page)

Figure 6. Full-page engraving by Lucas Kilian on p. 341 of the Cryptomenytices. It shows how dots that are represented by the eyes of men and animals in the picture as well as by the apples in the tree may serve to send a message. The duke's source was a similar picture in Johann Walch's 1609 collection, Decas fabularum humani generis.

We should not overlook this aspect of the duke's character during his Wolfenbüttel years: While still extremely frugal (except for his book purchases) and periodically checking on his wife's household expenses, he generously supported poets and scholars alike, as hundreds of extant panegyrics and expressions of gratitude testify.

Although Duke August's correspondence with Athanasius Kircher rekindled his active interest in cryptology, the aging ruler had never ceased purchasing relevant materials for his library. One of the rare books of the Wolfenbüttel period is a Grammatica Angelorum mysticorum sive labyrinthus cryptographicus, which Emmanule Rodriguez, a member of the Augustine order, published in Antwerp in 1639. As a religious man, Rodriguez frequently gave his cryptographic schemes (including material taken from Trithemius) a more orthodox appearance by assigning the names of saints and angels to them, as the title of his little book suggests.[43] Last but not least, Kircher might have acquainted the duke with his pupil Kaspar Schott, whose various mathematical and linguistic works contain a wealth of (frequently derivative) cryptological schemes; they begin to arrive at the library in the 1660's.

VI) The Fate of the Cryptomenytices after Duke August's Death

The fate of Duke August's compendium parallels to a certain extent the general interest in cryptology during the 17th and 18th centuries. One may take for granted that the German authors of the later 17th century knew the work well; frequently, however, praise was heaped upon the Cryptomenytices and its learned author with an eye to the reactions of his successors, which makes an honest assessment of the work well-nigh impossible. One notable exception is the Altdorf (Nuremberg) university professor Johann Christoph Wagenseil. In his Exercitationes sex varii argvmenti of 1687 he gives a detailed overview of cryptology and calls to task the Worms lawyer Wolfgang Ernst Heidel, who had claimed in 1676 (as had Juan Caramuel in 1635) in his book, Johannis Trithemii [...] Steganographia quae hucusque a nemine intellecta, to have elucidated the Steganographia once and for all. Heidel, who knows Gustavus Selenus through Schott's works (if not directly), follows to a great extent the duke's elucidations but avoids as much as possible demonstrating his indebtedness. When he reaches the problematic third book, however, and is on his own, he enciphers the "key" to this book which he claims to have discovered. Heidel's encipherment defies interpretation even today and would seem to be a subterfuge on the part of an author who was just as deadlocked as his predecessors.[44]

The Leipzig writer Johann Balthasar Friderici decided not to quibble with the question of sources at all: He simply omitted any reference to previous authors in his Cryptographia oder Kunst geheime Schrifften zu machen und

auffzulösen ("Cryptography or the Art to Create and Solve Secret Writings," 1684), yet he did not hesitate to copy his sources verbatim—including parts of August's preface and other sections of the Cryptomenytices. Since Schwenter's German treatises were no longer available, Friderici's book filled a growing demand and was quite successful. The author's plagiarism was detected and castigated within a few years, however.

F	E	R	D	I	N	A	T
B	C	G	H	K	L	M	O
P	Q	S	V	W	X	Y	Z

A	my	I	kw	R	gf
B	fb	K	iw	S	rg
C	eg	L	nx	T	oz
D	bu	M	ay	V	vg
E	cg	N	lx	W	ip
F	by	O	tz	X	nl
G	xf	P	fb	Y	am
H	dy	Q	ec	Z	to

*Wysse Geym Lufft notiret, h. 10. p. m.
16. Aug. 1663. Etat A. 84. 1/2 Mo. D. o.*

Figure 7. Substitution cipher written by Duke August at age 84, after he had received Kircher's Polygraphia nova of 1663. The key word, "Ferdinat," stands for "Ferdinand," the name of his youngest son, Ferdinand Albrecht.

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With the beginning of the 18th century, it appears the point was reached when Duke August's handbook--while far from being outdated--ceased to be a commonly-used reference work. Books began to appear in the more accessible vernacular, and interest in cryptology was on the wane, as the smaller number and poorer quality of publications would indicate. By the time we reach what one may regard the first truly "modern" manual in German, Johann Ludwig Klüber's Kryptographik of 1809, Duke August's Cryptomenytices is presented as an important link in the history of cryptology, is given its due credit as a valuable source, reference book and as a first even if only partial elucidation of Trithemius. Though today the Cryptomenytices has no practical use, it did organize the knowledge of cryptology of its time and broadcast it--and this was no mean achievement.

REFERENCES

1. "Gustavus" can easily be recognized as an anagram of "Augustus;" "Selenus" refers to the lunar goddess Selene and plays upon the name "Lüneburg" or "Lunaeburg," the "lunar" or "moon castle" which was a major city in the duchy.
2. Lüneburg: Gebrüder Stern, 1624. The modern Herzog August Bibliothek preserves four copies of this book, one of them (Fb 4^o 81) the working copy of Duke August.
3. See, in particular, David Shulman, An Annotated Bibliography of Cryptography, Garland Reference Library of the Humanities, 37 (New York, London: Garland, 1976), as well as my review article in Argenis: Internationale Zeitschrift für Mittlere Deutsche Literatur, 3 (1979), 351-358. Still valuable is Joseph S. Galland, An Historical and Analytical Bibliography of Cryptology, Northwestern University Studies in the Humanities, 10 (Evanston: Northwestern University, 1945).
4. Dieser Bücher Lust-Gezelt
 Mag ich billig wol erkennen
 Für ein Wunderwerk der Welt/
 Vnd es recht das Achte nennen.
Freuden- Lob- und Wunsch-Gedichte / Dem [...] Herrn Augustus [...]
(Helmstedt, 1661), 5, cited by Paul Raabe, "Das achte Weltwunder: Über den Ruhm der Herzog August Bibliothek," Wolfenbütteler Beiträge: Aus den Schätzen der Herzog August Bibliothek, ed. Paul Raabe. (Frankfurt: Klostermann, 1972), 1: 3-25 at 10.

5. A library had previously existed at the Wolfenbüttel court; in 1618, it was donated to the territorial university at Helmstedt. The Bibliotheca Augusta represented therefore the personal collection of Duke August the Younger.
6. See Maria von Katte, "Herzog August und die Kataloge seiner Bibliothek," ibid., 168-199, especially 169 and 185.
7. The Library Association Record, 59 (1957), 224. Quoted by Raabe, loc. cit.
8. Von Katte, 174-176.
9. Cryptological materials were frequently found in treatises on language, writing, alchemy, mysticism, or (secret) communication, which accounts for these classifications that may appear unusual to the modern reader. This matter--and the entire cryptological collection of Duke August--is discussed in detail in a recent article of mine, "Die kryptographische Sammlung Herzog Augusts: Vom Quellenmaterial für seine 'Cryptomenytices' zu einem Schwerpunkt in seiner Bibliothek," Wolfenbütteler Beiträge, V (1982), 82-121.
10. Fols. b^r-b2^v. In his working copy, the Duke added one more name, that of Augerius Busbegus.
11. In his historical overview, the Duke not only drew on Pliny or Tacitus but also on Plato, Aristotle and on more anecdotal matters in classical authors like Ovid and Horace.
12. For a recent summary account of Duke August and the Cryptomenytices, see David Kahn's standard work, The Codebreakers: The Story of Secret Writing (New York: Macmillan, 1967), 154 and 1002. The account, not altogether sympathetic to the duke's work, contains an erroneous attribution to Duke August of an introductory poem written in honor of the ruler. See my article, "Herzog Augusts Handbuch der Kryptographie: Apologie des Trithemius und wissenschaftliches Sammelwerk," Argenis, 3 (1979), 21-48, especially 39.
13. Much of this biographical material is now accessible in the catalogue to the exhibitions commemorating the 400th anniversary of Duke August's birth in 1979: Sammler, Fürst, Gelehrter: Herzog August zu Braunschweig und Lüneburg 1579-1666 (Wolfenbüttel: Herzog August Bibliothek, 1979), in particular Part I, "Herzog August--Leben und Wirken 1579-1666," and Part II, "Herzog August und seine Bibliothek."

14. This is how Maria von Katte, the person most familiar with the young duke, has characterized him. See Gerd Heinrich, "Nova Ithaka: FÜRSTLICHES Landleben und soziale Wirklichkeit im Herzogtum Dannenberg-Hitzacker zwischen 1605 und 1635," Fruchtblätter: Freundesgabe für Alfred Kelletat, ed. Harald Hartung et al. (Berlin: Pädagogische Hochschule, 1977), 257-83, especially 260-68.
15. Von Katte, "Herzog August und die Kataloge," 170-71.
16. Loc.cit.
17. Leipzig: Henning Gross d. J., 1616.
18. The duke wanted "to create a thing of small perfection—as much as that can be done in this world." Quoted by Marion Faber in her article on "Schachspiel," Sammler, Fürst, Gelehrter, 173-80 at 173.
19. Ibid., 174-76.
20. In various public speeches given and edicts issued during his tenures as honorary president of the Rostock and Tübingen universities, Duke August admonished the students to lead decent lives and to avoid the sins of youth, namely lasciviousness, lust, and gambling H. Apfel, "August der Jüngere [...] als Rector der Universitäten zu Rostock und Tübingen," Mittheilungen über August den Jüngern, Herzog zu Braunschweig und Lüneburg, (Wolfenbüttel: Holle, 1854), 1: 7-15. Nonetheless, his Latin farewell address to the university of Tübingen (Oratio de recta rei-publicae litterariae constitutione, published in Tübingen in 1598) contains the admission that a game of dice and board games—when used for recreational purposes—could actually be beneficial to the relaxation of students. As a university president, Duke August would thus tolerate such games and certain forms of gambling—within limits, of course—although he would prefer physical exercise for the young men. See "Herzog August [...]: Über den zweckmässigen Aufbau einer Hohen Schule (1598)," translated from the Latin by Peter Mortzfeld and Maria von Katte, Wolfenbütteler Beiträge, 3 (1978), 155-89, at Introduction, 157-58.
21. Much of the manuscript material of Duke August is kept at the Herzog August Bibliothek and the Niedersächsisches Staatsarchiv Wolfenbüttel. For some representative samples see my chapter on "Geheimschrift" in Sammler, Fürst, Gelehrter, 181-91, especially 190, catalogue item 388. (Since page proofs of this chapter never reached me, two erroneous references to illustrations in the text should be corrected here: p. 183, portrait of Trithemius, belongs to catalogue item 383; p. 185, a section of a

- Trithemian manuscript which Duke August began to decipher, is taken from item 374).
22. Strasser, "Die kryptographische Sammlung." Detailed bibliographical references to the books discussed here can be found in this article.
 23. In quibus et planissima STEGANOGRAPHIAE à JOHANNE TRITHEMIO, Abbate Spanheymensi et Herbipolensi, admirandi ingenij Viro, magicè et aenigmaticè olim conscriptae, ENODATIO traditur. See also Strasser, "Herzog Augusts Handbuch," 22-24, for further bibliographical references.
 24. For a good overview in English of this confusing situation see Kahn, 130-37, and 998-1000. The most recent account in German is by Klaus Arnold, Johannes Trithemius (1462-1515), Quellen und Forschungen zur Geschichte des Bistums und Hochstifts Würzburg, 23 (Würzburg: Schönigh, 1971), 187-195.
 25. Philip M. Arnold, "An Apology for Jacopo Silvestri," Cryptologia, 4 (April 1980), 96-103; F. Wagner, "Studien zu einer Lehre von der Geheimschrift," Archivalische Zeitschrift (Cologne), here Part II: 12 (1887), 1-29, especially 19.
 26. The copy with the shelf number 323 Quod. (2) still bears the duke's (?) dog-ear on page 312, since the printer was instructed to copy pp. 312-18 and 328-29 in the Cryptomenytices—minus the typographical errors of the original, which Duke August had carefully corrected. On the connection of letter locks with cryptography, see Louis Kruh, "The Genesis of the Jefferson-Bazeries Cipher Device," Cryptologia, 5 (October 1981), 193-208.
 27. The modern-day Erlangen-Nuremberg university is the successor to the Altdorf institution; Altdorf is some 10 miles outside the city limits of Nuremberg. Contrary to what the short title of this book might suggest (which has misled many a bibliographer), the book is in German. Schwenter's two pseudonyms (Resene Gibronte Runeclus Hanedi, and Janus Hercules à Sunde) keep wreaking havoc in bibliographies, including Shulman's. Between 1624 and Schwenter's death in 1636, Duke August entered into a learned correspondence with this mathematician and linguist which also touched on cryptology. He even presented Schwenter with a gold chain at his wedding.
 28. Up to then, each author had faithfully—and unquestioningly—retold the story of the two friends about to be separated for a while. They devised a scheme whereby they would prick each other's arm and exchange a few drops of blood, thereby creating a strange kind of Sympathia within their

systems. They now could communicate over long distances by simply pricking these same spots on their arms and using an agreed-upon code. But, all the authors report, the danger in creating such intimate Sympathia was that sickness or death of one partner would cause the very same "sympathetic" response in the other.

29. For a detailed analysis of the entire Cryptomenytices, see Strasser, "Herzog Augusts Handbuch," 26-46, which contains further references.
30. Kahn, 131-32, with an example. See also the in-depth analysis of Trithemius's works in Wayne Shumaker's book, Renaissance Curiosa, Medieval and Renaissance Texts and Studies, 8 (Binghamton, New York: Center for Medieval and Early Renaissance Studies, 1982), Chapter Three, "Johannes Trithemius and Cryptography." This analysis obviates a more detailed treatment here.
31. Dr. John Henry Walden, the author of the unpublished translation of the Cryptomenytices into English (made early in this century; typescripts are at the Library of Congress and at the University of Chicago) managed to do just that and solved these formulas quite easily.
32. This is the opinion of Daniel P. Walker, Spiritual and Demonic Magic from Ficino to Campanella, Studies of the Warburg Institute, 22 (London: The Warburg Institute, 1958), 85-90, which Arnold (Johannes Trithemius, 188-89) and Kahn (loc. cit.) accept. Shumaker's conclusions on this subject (Renaissance Curiosa, 90, 105-109, 130-131) contradict these authors since Shumaker feels "the label 'Magical' would be accurate, but the magic is natural, not daemonic, and the subject of the third book is the same as that of the others" (90).
33. Trithemius's "steganographic" method has been treated "plus ouvertement, et sans laisser aucune difficulté, par Gustauus Selenus qui nous a donné depuis vn an l'entiere explication de cette Steganographie" Gabriel Naudé, Apologie povr tovs les grands personnages qui ont esté faussement soupçonnez de Magie (Paris: Targa, 1625), 511-12.
34. Wagner, "Studien," 24 and note 1. Wagner is correct in assuming that there was no second edition of the Cryptomenytices, although there is every reason to believe that Duke August's corrections and annotations in his own "working copy" were made with an eye to such a second edition.
35. Letter of [Etienne] Polier to Samuel Hartli(e)b in London; dated Paris, October 8, 1655. I am indebted to Professor Leonard Forster, Cambridge, for this reference.

36. This hope is expressed in the preface to the work (fol. a6^V).
37. "Alles mit Bedacht" is the German version of this device; a lengthy translation might be, "Everything with great care and consideration."
38. See Werner Arnold, "Reich und Territorien," and Christof Römer *et al.*, "Landesfürst in Braunschweig und Wolfenbüttel 1635-1666," Sammler, Fürst, Gelehrter, 83-114 and 115-147, especially 115-17.
39. Martin Bircher *et al.*, "Die Hofkultur in Braunschweig und Wolfenbüttel 1635-1666," *ibid.*, in particular 211-31.
40. Von Katte, "Herzog August und die Kataloge," 177.
41. Strasser, "Athanasius Kirchers Verbindungen mit Herzog August und dem Haus Braunschweig-Lüneburg," Athanasius Kircher und seine Beziehungen zum gelehrten Europa seiner Zeit, ed. John Fletcher, Wolfenbütteler Arbeiter zur Barockforschung, Band II (Hamburg: Hauswedell, 1983.)
42. It is surprising that Kircher, who praised the Cryptomenytices on several occasions in his Polygraphia of 1663, knew the work only through secondary sources before asking the duke for a copy in 1664, which he promptly received.
43. This rare work is not listed in any subject bibliography. The only other copies known to me are at the Bibliothèque Nationale and at the Folger Shakespeare Library.
44. Walker, Spiritual and Demonic Magic, 88.